LONG-TERM MONITORING PLAN:
Draba asterophora var. *asterophora* & *Draba asterophora* var. *macrocarpa*
(Online Version: Sensitive plant locations omitted)

USDA FOREST SERVICE
ELDORADO NATIONAL FOREST, HUMBOLDT-TOIYABE NATIONAL FOREST
& LAKE TAHOE BASIN MANAGEMENT UNIT

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September 2013

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INTRODUCTION

Draba asterophora var. *asterophora* (Tahoe Draba) and *Draba asterophora* var. *macrocarpa* (Cup Lake Draba) are small alpine perennials of the Brassicaceae. The species is characterized by a "pincushion" growth form where all the foliage grows close to the ground in a short mound or mat. The leaves grow in small basal rosettes and are dark green with white/silver stellate hairs. The bright yellow flowers are born on numerous flowering stalks 3-8 cm tall. *Draba asterophora* var. *macrocarpa* is distinguished from *D. asterophora* var. *asterophora* by its slightly larger petals, styles, and seed pods (Baad 1979; Calflora 2010).

Both *Draba asterophora* var. *asterophora* and *Draba asterophora* var. *macrocarpa*, herein referred to as *Draba asterophora* unless a specific variety is identified, occur on exposed talus and boulder slopes with minimal groundcover and a sparse understory, at elevations above 2500m (Hickman 1993). Soils are typically of granitic parent material but can also be volcanic in origin. The pincushion growth form serves to minimize the impacts of wind while taking advantage of warmer temperatures at ground-level. Stellate hairs on the foliage reflect visible light rays while trapping heat rays, which warms the plants but also helps reduce water loss and desiccation (Zwinger & Willard 1972). Alpine perennials growing in such environments typically are long-lived and develop extensive root systems. Reproduction by *D. asterophora* plants is limited by a lack of establishment from seed and a short growing season.

The current distribution of *Draba asterophora* var. *asterophora* is limited to the northern Sierra Nevada in the vicinity of Lake Tahoe, from Mount Rose (Washoe County, NV) in the north to the Freel Peak/Jobs Sister area (El Dorado & Alpine Counties, CA) in the south (Table 1, CDFG-CNDDB 2011). Four element occurrences (consisting of approximately 30 sub-element occurrences) exist on Lake Tahoe Basin Management Unit (LTBMU) lands, two of which have additional adjacent sub-element occurrences that are located on the Humboldt-Toiyabe National Forest (HTNF). Two historical populations, one on Mount Gibbs (Mono County, CA) and one northeast of Sonora Pass (Alpine County, CA), have not been relocated since they were first documented in 1916 and 1936, respectively. The distribution of *Draba asterophora var. macrocarpa* is even more limited; it is known from only two element occurrences in the Desolation Wilderness. One is adjacent to Cup Lake on the Eldorado National Forest (ENF) and the other consists of multiple sub-element occurrences along the ridge from Talking Mountain to Ralston Peak (LTBMU).

Table 1. Summary of known *Draba asterophora* var. *asterophora* (DRASA) and *Draba asterophora* var. *macrocarpa* (DRASM) populations (CDFG-CNDDB 2011, NNHP 2011).

Variety	**NDDB Occurrence (LTBMU EO)**	**Land Owner/Manager**	**Location**	**Date Last Observed**	**Number of Plants at Last Visit**	**Long-Term Monitoring**
DRASA	1(1)	LTBMU	Freel Peak	2009	>4000	X
DRASA	2	LTBMU	Jobs Sister	1974	not found, revisit 2012	
DRASA	4(1)	LTBMU	Star Lake	2009	>1000	X
DRASA	6	INF / YNP	Mt Gibbs	1916	?	
DRASA	7	HTNF	Jobs Peak	1989	>2000	
DRASA	9(1)	LTBMU	Freel Peak	2009	>2000	
DRASA	10(2)	LTBMU / HTNF	Heavenly Ski Area	2009	>4000	X
DRASA	12	HTNF	NE of Sonora Pass	1936	?	
DRASA	NNHP[1](3)	LTBMU / HTNF	Mt Rose / Relay Peak	2009	>2500	X
DRASA	NNHP[1]	HTNF	Mt Rose Ski Area	2005[2]	2,000[2]	X
DRASM	1	ENF	Cup Lake	2004	>1000	Recommend
DRASM	2(1)	LTBMU	Saucer Lake	2009	>1500	X
DRASM	3(1)	LTBMU	Ralston Peak	2011	not found	

LTBMU=Lake Tahoe Basin Management Unit, ENF=Eldorado National Forest, HTNF=Humboldt Toiyabe National Forest, INF=Inyo National Forest, YNP=Yosemite National Park

[1]Nevada Natural Heritage Program, no occurrence# assigned

[2]Date and population size most recently entered into the NNHP database.

Both varieties of *D. asterophora* are designated as United States Forest Service (USFS) Sensitive Species and as Tahoe Regional Planning Authority (TRPA) Sensitive Species. *Draba asterophora* var. *asterophora* has a California State Rank of S2 (*imperiled*) and a Global Rank of G2 (*imperiled*) (CDFG-CNDDB 2011), and is included on the California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants on list 1B.2 (*rare, threatened, or endangered in CA; fairly endangered in CA*) (Calflora 2010). *Draba asterophora* var. *macrocarpa* has a California State Rank of S1 (*critically imperiled*) and a Global Rank of G2 (*imperiled*) (CDFG-CNDDB 2011), and is included on the CNPS Inventory of Rare and Endangered Plants on list 1B.1 (*rare, threatened, or endangered in CA; seriously endangered in CA*) (Calflora 2010).

Human activities that pose direct threats to *D. asterophora* include those that might trample or uproot plants, such as recreational activities (e.g. camping, hiking, equestrian use, trail construction) and grazing. Snowmobile traffic in closed areas and across patches of bare ground/low snow cover may increasingly be cause for concern at the Mount Rose and Freel Peak/Jobs Sister areas. *Draba asterophora* var. *asterophora* occurrences are found at both Heavenly and Mt Rose Ski Areas; construction and maintenance of ski facilities have the potential to directly impact entire *Draba asterophora* var. *asterophora* occurrences. Translocations of plants prior to lift construction projects at both ski areas have been unsuccessful (Bergstrom, E & Gross, S; personal communication 2011). These results demonstrate that translocation is not an effective mitigation strategy. A Memorandum of Understanding (MOU 2006) is in place between the US Forest Service (LTBMU and HTNF), Mt Rose Ski Tahoe, Heavenly Ski Resort, and the TRPA, in order to cooperatively execute conservation measures for Tahoe Draba within its present range. Finally, climate change may adversely affect *D. asterophora* populations through its influence on precipitation type, timing and quantity; changes in associated plant community composition and species interactions; and decoupling of plant phenology and insect pollinator visitation.

While census counts are completed on a five year cycle, there is currently no long-term monitoring of *Draba asterophora*. The demography and genetics of *D. asterophora* are being investigated as part of a dissertation research project. Preliminary results indicate that grading of ski runs is correlated with lower plant densities, smaller plant sizes, and a higher annual mortality rates. In addition, genetic analyses have found that ploidy levels vary between the three main population clusters, suggesting the presence of multiple taxa (Smith et al. 2008). As a part of this study, individual plants were tagged in 2007 for long-term monitoring; however they could not be relocated in 2009. Long-term monitoring at multiple populations is necessary to document the variation in population trends and site characteristics across the entire range of the species. The largest number of plants is contained in the LTBMU populations; thus the status of LTBMU populations is critical to the viability of the entire species. This monitoring plan was developed in conjunction with botany staff from the Humboldt Toiyabe National Forest and is being conducted at populations on both forests. Coordination has also occurred with botany staff from the Eldorado National Forest. The one population of *Draba asterophora* var. *macrocarpa* on the El Dorado National Forest is recommended for monitoring.

MANAGEMENT OBJECTIVES

Forest Service objectives for Sensitive Species are to 1) develop and implement management practices to ensure the species does not become threatened or endangered because of Forest Service actions, 2) maintain viable populations of all native plant species in habitats throughout their geographic range on National Forest System lands, and 3) develop and implement management objectives for populations and/or habitats of sensitive species (FSM 2005). In addition, both the USDA Strategic Plan – FY 2010-2015 and the USFS Strategic Framework for Responding to Climate Change set a goal of "…leading efforts to mitigate and adapt to climate change." The USFS Climate Change Performance Scorecard contains a "Monitoring" element, which tasks each National Forest with "conducting monitoring to track the impacts of climate change and the changing conditions of species, watershed condition, forest and grassland health, and other measures, and the effectiveness of treatment programs."

The TRPA has also established specific vegetation thresholds to provide for the conservation of uncommon plant communities and sensitive plant species in the Lake Tahoe Basin. For sensitive plants, the indicator of threshold attainment is "the number of population sites that are maintained as suitable habitat (as determined by a qualified expert)." For *D. asterophora*, the goal is to maintain a minimum of five population sites for *D. asterophora* var. *asterophora*, and two population sites for *D. asterophora* var. *macrocarpa* (TRPA 2007).

Additionally, the MOU contains specific actions, to be executed by the participating entities, to provide for the conservation of *Draba asterophora* var. *asterophora*. Actions to be completed by the Forest Service (both LTBMU and HTNF) include the following:

> 1) Assist in defining potential habitat, conduct baseline inventories, seed collection, transplant efforts, and monitoring, to the fullest extent possible. Review and evaluate restoration efforts.
>
> 2) Initiate the development of a Conservation Assessment/Strategy which incorporates management of Tahoe Draba across its known range and various management situations.

In order to meet the objectives described above, the majority of LTBMU *Draba asterophora* populations have been censused by LTBMU botany staff a minimum of two times since 2004.

As of 2010, of the 34 *Draba asterophora* var. *asterophora* sub-Eos on the LTBMU, nine percent (3 of 34) had increased and 65 percent (22 of 34) were stable, compared to initial counts in 2004 (Figure 1). Only one population (3 percent) had decreased in size (Figure 1). Twenty-three percent (8 of 34) were of unknown status due to only one census count or the inability to completely survey the population because of safety concerns (Figure 1). The population that decreased, DRASA 3h near Mt Rose, was first identified in 2009 and had 30 individuals but was not relocated in 2010. However, it is likely that this population was censused as part of the DRASA 3g population in 2010, because DRASA 3g increased from nine plants in 2009 to 33 plants in 2010 and they occur in close proximity.

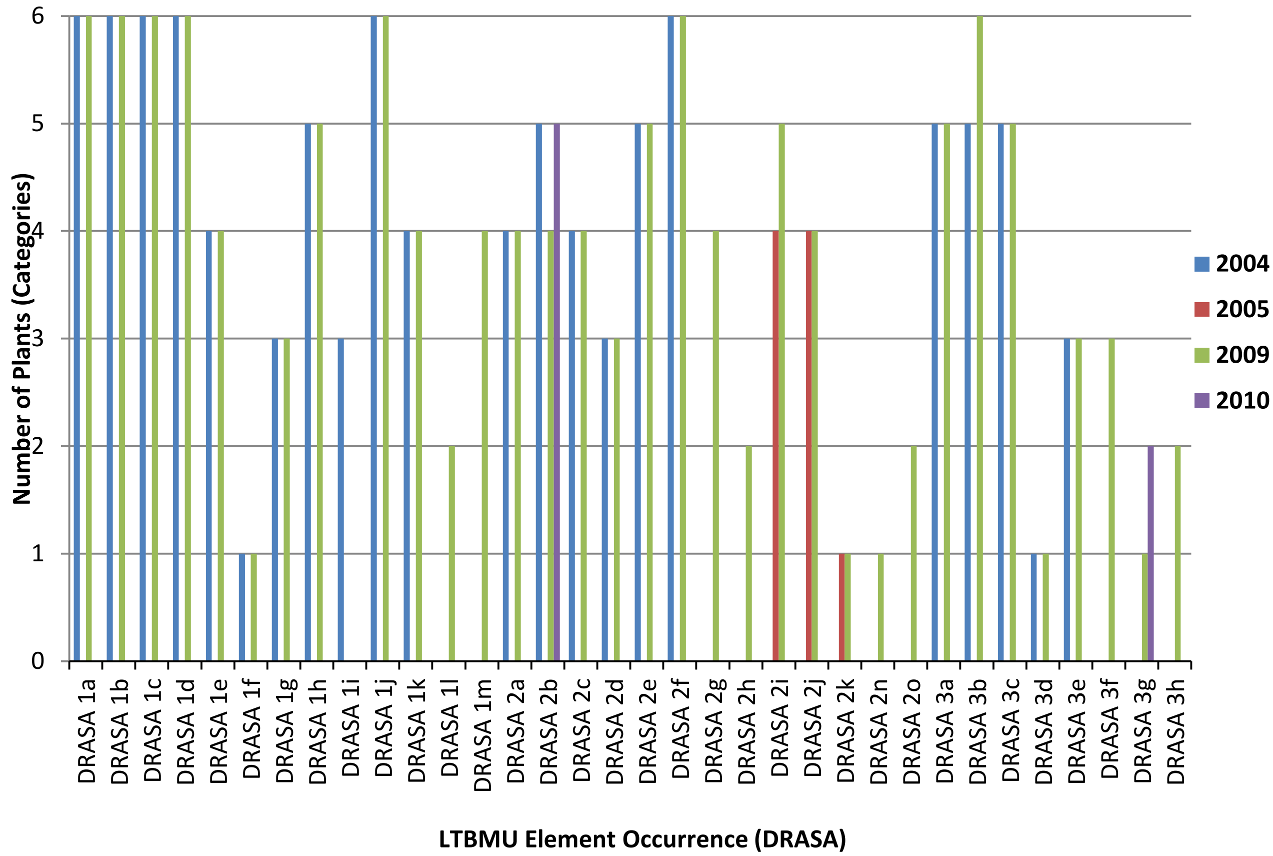


Figure 1. Census results of *Draba asterophora* var. *asterophora* populations on the LTBMU from survey years 2004, 2005, 2009, and 2010. Categories for the number of plants found are: 1 = 1-14, 2 = 15-99, 3 = 100-249, 4 = 250-499, 5 = 500-1000, 6 = >1000.

As of 2010, of the seven *D. asterophora* var. *macrocarpa* sub-EOs at Saucer Lake/Ralston Peak, two had increased in number, three were stable, and two had decreased (Figure 2). DRASM 1a (below Saucer Lake), which had 43 plants in 2004, could not be relocated in 2009 or 2010. The decline of this population may be due to its occurrence in marginal habitat (large amounts of litter). DRASM 1g (Ralston Peak), which was identified but not censused in 2004, could not be relocated in 2010. The exact location of this population is currently uncertain and the terrain quite hazardous; the population may be extant but impossible to access safely.

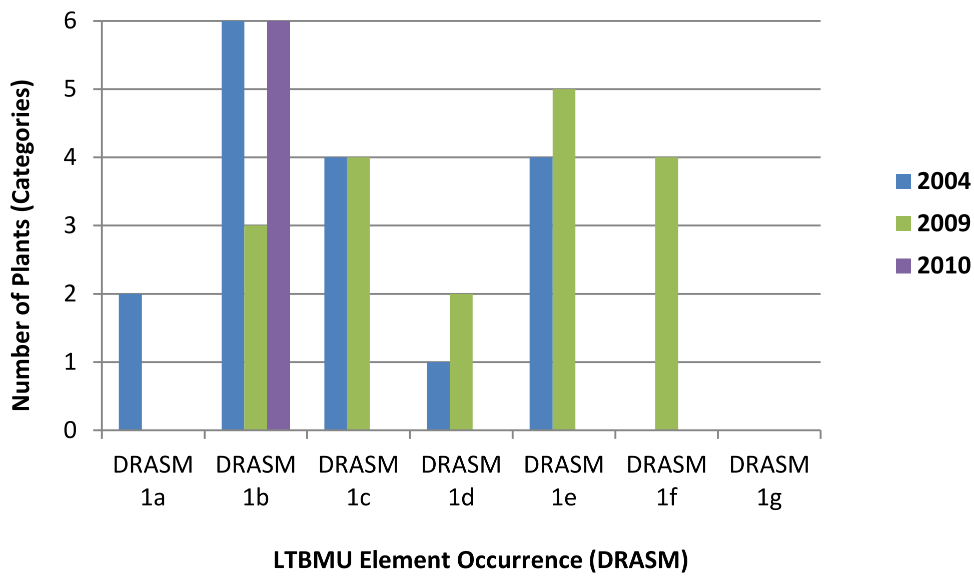


Figure 2. Census results of *Draba asterophora* var. *macrocarpa* populations on the LTBMU from survey years 2004, 2009, and 2010. Categories for the number of plants found are: 1 = 1-14, 2 = 15-99, 3 = 100-249, 4 = 250-499, 5 = 500-1000, 6 = >1000.

As of 2010, the single *D. asterophora* var. *macrocarpa* EO on the Eldorado National Forest was considered stable (Figure 3). Census data was not actually collected in 2002, but the population was noted to be stable since 1992. In 2004, only 370 plants were observed, but it is unclear whether a complete census was made of the population. No impacts were noted at the time. Data was not available to evaluate status of the Humboldt-Toiyabe National Forest *Draba* EOs.

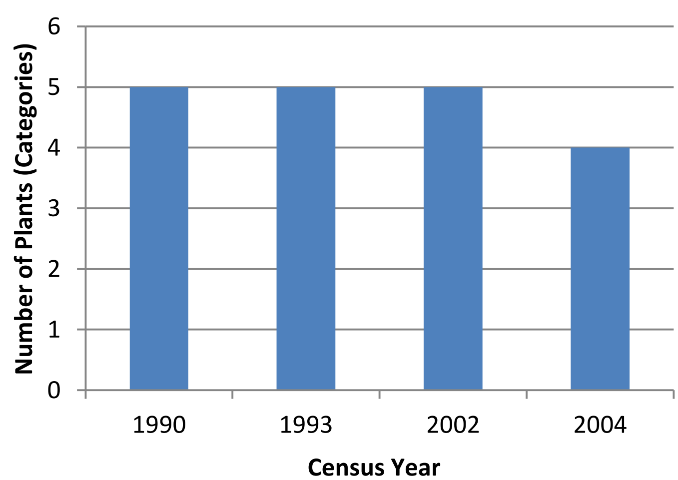


Figure 3. Census results from the Cup Lake *Draba asterophora* var. *macrocarpa* population on the ENF from survey years 1990, 1993, 2002, and 2004. Categories for the number of plants found are: 1 = 1-14, 2 = 15-99, 3 = 100-249, 4 = 250-499, 5 = 500-1000, 6 = >1000.

There is currently a lack of scientific data concerning the species' demography, reproductive biology, and competitive interactions. Therefore the initial steps toward fulfilling the management objectives are to gather additional information on the status and trends of as many populations as possible. The design of a long-term monitoring protocol can be established in such a way that information regarding the species' demographic structure, environmental tolerances, and species interactions also can be gathered.

In 2010, permanent long-term monitoring plots were established at nine sub-element occurrences within all four LTBMU *Draba asterophora* element occurrences. Monitoring was established in 2011 at three sub-element occurrences within two *Draba asterophora* var. *asterophora* element occurrences on the Humboldt Toiyabe National Forest. If time permits, monitoring will be established in 2012 at the *Draba asterophora* var. *macrocarpa* element occurrence on the Eldorado National Forest. The intent of the long-term monitoring is to more quantitatively and consistently determine the status and trend of the populations. The populations selected for monitoring have more than 1000 plants, making it difficult to accurately count individuals or determine population trends. Monitoring in permanent plots will allow for more repeatable and efficient surveys in order to determine population status. In addition, the pincushion growth form can result in surveyor differences in identification of individual plants (i.e. the counting unit). A standardized rule for identifying an individual was developed as part of this monitoring protocol (>2 cm considered a different individual). Long-term monitoring will also provide information on longevity of individual plants and plasticity of life stages, demographic structure and reproductive success, effects of annual climate patterns, and the characteristics of suitable habitat (percent vegetative cover and percent ground cover composition). This information can be combined to better interpret *D. asterophora* population changes.

STUDY DESIGN

Monitoring Questions

1. What is the status and trend of *Draba asterophora* density and plant size within the Lake Tahoe Basin? What is the relationship between plant size and reproductive success?

2. What is the status and trend of *Draba asterophora* demographic structure (life history stages: vegetative, flowering, fruiting, and dehiscent) within the Lake Tahoe Basin? "Dehiscent" was included as a life history stage in order to document completion of the reproductive cycle. If seedlings can be determined based on size data then this will be added as a fifth life history stage.

3. What are the transition rates between four stage classes (small-vegetative, large-vegetative, small-reproductive, and large-reproductive)? If seedlings can be determined based on size data then this will be added as a fifth stage class. How much do these rates change annually? Given the current transition rates, what is the probability of population extinction within 50, 100 and 500 years?

4. Are changes in climate (total snowfall, timing of spring runoff) influencing the density, demographic structure or transition rates of *D. asterophora* populations?

5. Are changes in inter-specific competition (total vegetative cover) or habitat suitability (ground cover, erosion features) related to density, demographic structure or transition rates of *D. asterophora* populations?

6. Are there noticeable differences in trends in density, demography, population viability, competition, or habitat characteristics of *D. asterophora* populations that occur at ski areas compared to those that occur in remote locations?

Monitoring Objectives

1. Density & Plant Size: The number of *D. asterophora* plants in plots will be counted in order to detect recruitment or loss of individuals. The size of each *D. asterophora* plant will be measured in order to detect changes in plant vigor. This information will be used to infer the general trend in the status of the population (increasing, decreasing, or stable). The relationship between plant size and reproductive output will be used to gauge the consequences of changes in plant density and/or plant size.

2. Demographic Structure & Reproductive Output: The number of plants in each of four life history stages (vegetative, flowering, fruiting or dehiscent) will be used to characterize demographic structure. The size (pincushion area) and the number of inflorescence stems will be observed in order to determine the size at which *D. asterophora* plants may begin to produce fruits, and the relationship between plant size and reproductive output. If a consistent size cutoff between seedling and vegetative plants is observed, seedling will be used as a fifth life history stage. This information can then be used to further explain the nature of population changes (e.g. a decline in recruitment, a decline in flowering plants, a decrease in reproductive output, or a decline in the entire population).

3. Population Viability Analysis: Tracking the stage class of individual plants over multiple years will provide data on transition rates between different stage classes and demonstrate whether an individual plant is able to alternate between increasing growth for survival or increasing seed production for fecundity. This information will also allow for comparison of survivorship between populations and can be used in a population viability analysis to determine the likelihood of population extinction in the future.

4. Climate Change: Density, demographic structure (life history stage), and/or stage class transition rates may vary with the precipitation and climatic conditions of that particular year. Data on date of greatest Snow-Water-Equivalent (SWE) and date of SWE=0 will be used to better understand the relationship between population changes and climate change variables. The source of the SWE data will be the nearest SNOTEL site: Echo Peak, #463; Heavenly Valley, #518; Hagan's Meadow, #1050; or Mt. Rose Ski Area, #652 (NRCS-SNOTEL 2011).

5. Competition & Habitat Suitability: *Draba asterophora* typically occur at sites characterized by a sparse understory with high amounts of bare ground. The total cover of all non-*D. asterophora* vegetation, as well as ground cover composition, will be recorded for each plot in order to identify changes in competition pressure ad habitat suitability at each population. Changes in total vegetative cover or ground cover composition within the monitoring plots will be evaluated as an explanation for changes in *D. asterophora* density and demographics.

6. Ski Area Effects: Ski area activities, such as ski run grading, snow making, roads, and construction projects, have been found to have deleterious effects on *Draba asterophora* plants. Populations that occur at ski areas will be compared to those that occur in more remote locations, to assess the potential impacts of ski area activities on population density, demography, viability, competition, and habitat suitability.

Monitoring Design & Protocol

This study's monitoring design was developed by ecology and botany staff of the LTBMU and HTNF, and utilized a plot design that had previously been effective in tracking individual plants of a different species. Monitoring on the LTBMU, HTNF, and ENF will follow the same protocol; this will allow analysis on population trends across forest boundaries, and comparison between the two forests.

Long-term monitoring plots were established at nine populations within the four *D. asterophora* Element Occurrences on the LTBMU. These populations are located in the vicinity of Freel Peak/Star Lake (DRASA 1a, 1b, 1d, 1j), Heavenly Ski Area (DRASA 2b, 2f), Mt. Rose (DRASA 3b), and Saucer Lake/Ralston Peak (DRASM 1b, 1e) (Appendix 1). The Freel Peak/Star Lake populations are in non-motorized backcountry areas, but they have the potential to be disturbed by foot traffic and illegal snow mobile use. The populations at Heavenly Ski area are fenced in the summer to prevent damage by maintenance vehicle traffic or other mountain operations; winter snow coverage should protect them from skier and snowmobile impacts. The population at Mt. Rose is fairly remote and in a summer non-motorized area; however snowmobile use is legal in the winter and could potentially impact the population during periods of low snow cover. The Saucer Lake populations are at remote locations within Desolation Wilderness.

Long-term monitoring plots were established in 2011 at three sub-element occurrences within two *D. asterophora* var. *asterophora* Element Occurrences on the HTNF. These populations are located in the vicinity of Relay Peak (DRASA-Tam) and Mt Rose Ski Area (DRASA-Rose1 & Rose2) (Appendix 1). The Relay Peak population is located in a fairly remote non-motorized area that is most heavily visited in the winter (by backcountry skiers) and is adjacent to a winter motorized use area. The populations at Mt Rose Ski Area are both located on graded ski runs. Monitoring will possibly be established at the Cup Lake DRASM population in 2012. This site is in a relatively remote portion of the Desolation Wilderness and experiences relatively light use by hikers during the summer.

At each population, two to four permanent transects were established within the boundaries of the population. Transects were systematically located such that plots placed randomly along the transect would contain at least one plant in most plots. At least one transect was oriented parallel to the slope, and at least one transect was oriented perpendicular to the slope. Transect location diagrams and details on layout (length, bearing, endpoint UTMs, and photographs) are found in Appendix 2. Site elevation, slope, and aspect, as well as transect bearing, were collected during plot establishment.

The start and end of each transect were permanently marked with rebar, and transect photographs were taken from each end. After a meter-tape was stretched between the two rebar, plots were placed along one side of the transect (when viewed from 0m; typically the left side- notes provide specific details). Plot locations were determined by randomly selecting numbers corresponding to whole meters along the transect tape (i.e. 1m, 5m, 7m, 13m, etc). Only one plot per transect was allowed to have zero *D. asterophora* plants; if more plots had zero plants, additional random numbers were selected. The goal was to establish at least twenty plots per population, representing a minimum of 100 *D. asterophora* plants in total. Because complete randomization was not employed to locate transects and plots, caution should be used when extrapolating beyond the measured sample of the population.

The bottom edge of the plot was placed parallel to the meter-tape. Plot locations were permanently marked at two corners (typically the lower left and upper right- notes provide specific details) with a large nail and blue stake chaser (Figure 5a). A small metal tag with the Plot ID# was attached to the nail at the lower left corner. Plot ID numbers and locations along transects are summarized in Appendix 3.

After testing several different size plot frames, a frame that was 0.75m by 0.75m (~$0.6m^2$) was selected because it captured a sufficient number of plants yet was small enough that one surveyor could still view the entire plot. The plot frame was divided into four quarter plots that were each further divided into four sixteenth plots (Figure 5b). The quarter and sixteenth plots were numbered one through four starting from the upper right and moving counter-clockwise. *Draba asterophora* plants were mapped based on their location in the quarter plot and the sixteenth plot (Figure 5b). Moving sequentially through each quarter plot-sixteenth plot combination (i.e. starting at 1,1 then 1,2 then 1,3, etc), each *D. asterophora* plant within the plot was given a Plant ID (e.g. A, B, C) and its location was recorded. The location of each individual was also mapped for relocation during future visits by marking each Plant ID on the Plot Map Datasheet. Plants were considered different individuals if they were greater than 2cm apart.

a) 

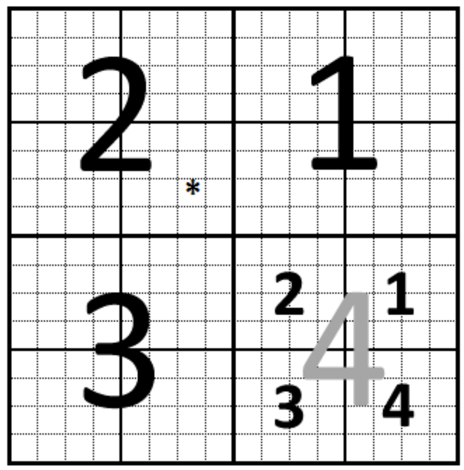
b) 

Figure 5. a) Photograph of plot layout with nail, tag, and blue stake chaser marking the lower left corner of the plot, and nail with blue stake chaser marking the upper right corner of the plot.
b) Diagram of the plot design, with 1/4 plots 1 through 4, and 1/16 plots 1 through 4. A plant occurring at the star would be given a location of 2,4.

After each plant was mapped, it was measured. Plant size consisted of two measurements made with a small ruler- the longest diameter and the widest perpendicular diameter of the plant. A multiplier of 0.25, 0.5, 0.75 or 1 was also recorded to adjust the calculation of plant area for irregular or non-square plant shape and/or incomplete plant canopy cover. For each plant, the number of inflorescence stems and the inflorescence stage (flowering, fruiting, dehiscent) were recorded.

The percent cover of *D. asterophora* and the total percent cover of all other vegetation in the plot were recorded. Ground cover (bare ground, litter, and rock (>3/4")) of each plot was recorded as a total of 100%. Basal vegetation was not considered in ground cover because the goal was to characterize the substrates available for plant establishment and growth. Notes were made if any erosion features were present in the plot (e.g. gullies, rills, deposition, etc). Each plot was photographed from directly above. Examples of the coversheet, plot datasheet, and plot map datasheet, along with detailed instructions for recording each field, are attached at the end of this monitoring plan in Appendix 4.

The monitoring protocol was designed with the goal of minimizing impacts to the populations (*sensu* Farnsworth 2005). The permanent markers do not affect snow accumulation or soil compaction and they do not attract undue attention to the populations. Monitoring was only set up at 9 of 34 DRASA sites and 2 of 7 DRASM sites (all of which are comprised of greater than 1000 individuals) on the LTB, the sites are only visited every three to five years, and the protocol does not require any destructive sampling. Trampling and soil movement are a concern when surveying in the steep sandy and rocky sites that Draba inhabits; however these impacts are minimized by traveling on durable substrates (e.g. rocks and slabs) as much as possible and by taking extra care to avoid disturbing *Draba* plants or soils.

Monitoring data and plot photographs will be stored at:
O:\NFS\LTBMU\Project\Monitoring\StatusTrend\Draba_asterophora LongTermMonitoring

The GIS shapefile consisting of transect start and end points will be stored at:
T:\FS\NFS\LTBMU\Project\Monitoring\StatusTrend\Draba

The *Draba* transect endpoints also will be included in the *BIO_Monitoring_Status_Trend* shapefile at:
T:\FS\NFS\LTBMU\Project\Monitoring\StatusTrend

Timing of Monitoring

Monitoring should occur in late summer (August-September) when plants are flowering, ideally within one week of the date of initial plot establishment and sampling, however late season snow could change monitoring timing. Monitoring will occur for two years after plot establishment to collect baseline data, and then every three to five years until a decision is made to cease monitoring this species (i.e. this species is no longer considered sensitive, rare, imperiled, etc). The monitoring schedule is presented in Table 2 and assumes a revisit every four years (actual schedule may change given the three to five year range).

Table 2. Schedule of visits to all *D. asterophora* monitoring sites within the Lake Tahoe Basin (nine sites), Humboldt-Toiyabe National Forest (three sites), and Eldorado National Forest (one site).

	Year						
	2010	**2011**	**2015**	**2019**	**2023**	**2027**	**2031**
LTBMU *Draba* monitoring sites	Establish/ Baseline	Baseline	Monitor	Monitor	Monitor	Monitor	Monitor

	Year						
	2011	**2012**	**2016**	**2020**	**2024**	**2028**	**2032**
HTNF DRASA monitoring sites	Establish/ Baseline	Baseline	Monitor	Monitor	Monitor	Monitor	Monitor
ENF DRASM monitoring sites	N/A	Establish/ Baseline	Baseline	Monitor	Monitor	Monitor	Monitor

DATA ANALYSIS & MANAGEMENT IMPLICATIONS

1. Density & Plant Size: Temporal changes in *D. asterophora* density and size will be explored graphically. Density will be represented by both the sum of plants at each transect and each site, and also by the average ± standard error at each transect and each site. These graphs will also be compared to trends in

the ongoing census counts of other *D. asterophora* populations. A paired t-test will be used to test for a significant difference in average density between years at each site individually and at all sites combined. For this analysis, *D. asterophora* density in each plot will be averaged over the entire site, ignoring the blocking effect of transect. After three years of data have been collected, a repeated-measures ANOVA will be used to test for any significant differences in average density between years, followed by paired t-tests with a Bonferroni correction for multiple comparisons to identify which years were significantly different.

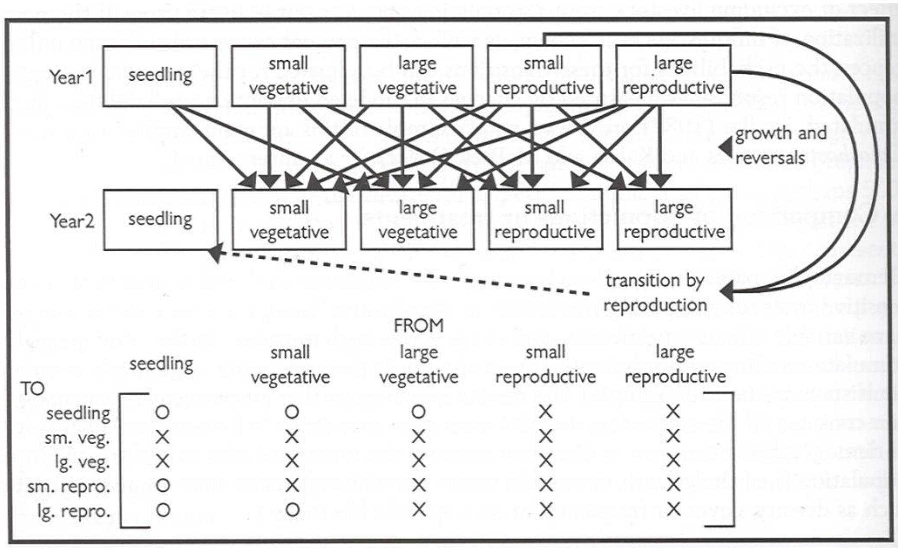
Analyses of plant size will follow similar steps. Plant size and number of inflorescence stems will be compared in a scatterplot and a regression analysis will be used to quantify the relationship between them. This relationship will be used to help interpret the consequences of changes in population density or plant sizes.

Quantitative measures of the changes in population density can be summarized with several simple equations (Barbour et al. 1999). The rate of population growth (R_0) is equal to the ratio of the future population size to the past population size: $R_0 = N_{t+1} / N_t$. A ratio greater than 1.0 indicates an increasing population, a ratio less than 1.0 indicates a decreasing population, and a ratio equal to 1.0 indicates a stable population. Density within the sampling plots can thus be compared between years and the rate of population growth compared between populations over discrete time periods. The rate of population increase (r) can also be calculated by subtracting the death rate (d) from the birth rate (b) (must assume that immigration and emigration rates are negligible): r = b – d (where the birth rate is = # births/# plants in the population; the death rather is = # death/# plants in the population). This equation provides a continuous –time model of population increase.

2. <u>Demographic Structure & Reproductive Output</u>: The life history stages used to describe demographic structure are (vegetative, flowering, fruiting, and dehiscent). If seedling can be determined based on size data it will be included as a fifth life history stage. Plant size and the number of inflorescence stems will be compared in a scatterplot to identify a plant size cutoff at which inflorescence stems are never produced. Any plant smaller than that size would be called a seedling. Temporal change in the demographic structure at each population will be displayed graphically using stacked column charts. A paired t-test will be used to test for a significant difference between years in the number and percentage of plants in each life history stage at each site. After three years of data have been collected, a repeated-measures ANOVA will be used to test for any significant differences in the percentage of each life stage between years, followed by paired t-tests with a Bonferroni correction for multiple comparisons to identify which years were significantly different. A decrease of 20% in the number of reproductive plants would be deemed undesirable for population viability. There is no scientific data available that would aid in determining such a threshold; 20% was selected based on BLM guidelines for maintaining population viability when making seed collections (SOS-BLM 2011). If such a decline was observed, the site would be revisited the following year. If two years of similar decline are observed, management strategies may consist of decreasing human impacts to plants or recommending complete protection for all populations.

3. <u>Population Viability Analysis</u>: Transition matrices summarize the probability of an individual plant moving from its current stage class to each of the other stage classes in the population (Figure 12.6; Elzinga et al. 1998). Stage classes used in this study are small-vegetative, large-vegetative, small-reproductive, and large-reproductive. If seedlings can be determined from the plant size data (as described above) they will be included as a fifth stage class. The distinction between small and large plants will be determined by using histograms of non-seedling plant size from two monitoring visits to

identify the natural cutoff above which larger plant sizes are significantly less frequent in the population (see example in Figure 7 below). If, after several monitoring visits, transition probabilities are determined to be similar for large and small plants, these size classes may be combined.



TO \ FROM	seedling	small vegetative	large vegetative	small reproductive	large reproductive
seedling	O	O	O	X	X
sm. veg.	X	X	X	X	X
lg. veg.	X	X	X	X	X
sm. repro.	O	X	X	X	X
lg. repro.	O	O	X	X	X

Figure 6. Life cycle diagram for a species with no seed bank, and a small and large class in both the vegetative and reproductive stage. Arrows represent possible transitions. Those possible transitions are identified in the transition matrix by and “X”, while those that are biologically impossible (or known to not occur) are given a “zero” in the matrix (Figure 12.5; Elzinga et al. 1998)

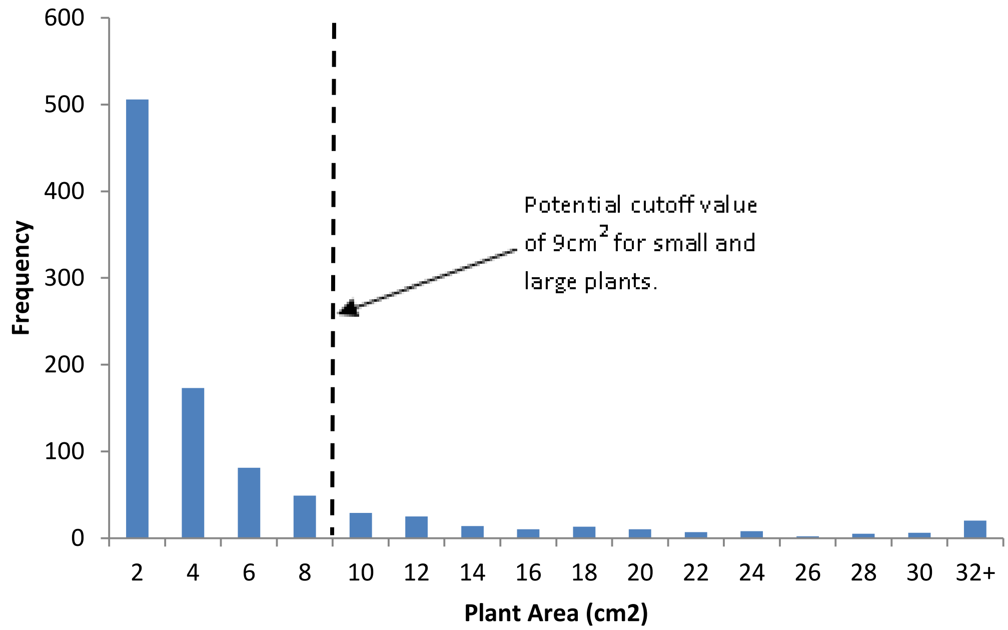


Figure 7. Frequency of *D. asterophora* non-seedling plant sizes.

Transition matrices will be computed for each population after two years of data are collected. Transition rates will be compared between populations. The matrices will be used to calculate lambda (λ), the "finite rate of increase," which integrates the transition rates between all the different stage classes. A lambda value greater than 1.0 indicates an increasing population and the larger the value, the faster the rate of increase, while a value less than 1.0 indicates a declining population (Elzinga et al. 1998). The transition matrix may also be used to project the population demographics into the future. Once several "transitions" have been measured, demographic modeling will be used to assess population viability (the cumulative probability of population extinction) over several time spans (50, 100, and 500 years) while accounting for different climate change scenarios.

Survivorship curves, which estimate the probability of surviving from birth to a given age, can be calculated from transition matrices following the methods of Cochran and Ellner (1992). These curves are useful for comparing probability of survivorship between multiple populations over a specified time period.

4. <u>Climate Change</u>: After three years of data collection, date of greatest Snow-Water-Equivalent (SWE) and date of SWE=0 will be plotted against plant density and average plant size (by site), as well as transition rates between the various stage classes. When a sufficient number of data points have been collected, a regression analysis may be used to characterize the relationship between plant density, plant size, and transition rates and these climate variables.

5. <u>Competition & Habitat Suitability</u>: Average ground covers and percent cover of total vegetation (non-*D. asterophora*) will be summarized by *Site X Year*. The change in percent cover for each ground cover type will also be summarized following successive monitoring visits. A summary of habitat variables will also be completed with sites grouped based on whether they occur at a ski area or not. A multiple regression analysis will be used to explore the relationships between plant density, plant size, and the various ground cover types. If it is determined that increasing vegetative cover or habitat changes are correlated with decreasing *D. asterophora* density, a possible management response could be experimental removal of vegetation or habitat manipulations (e.g. litter removal).

6. <u>Ski Area Effects</u>: Changes in population density, demography (proportion of plants in each life history stage), competition, and transition rates will be compared between populations grouped by their occurrence at ski areas or not. T-tests and/or graphical comparison will be used to investigate differences between the two groups.

Microsoft excel will be used to calculate descriptive statistics and to produce basic graphs and tables. SigmaStat will be used for t-test, ANOVA, and regression analyses. Analysis of monitoring data will be completed following baseline data collection and then following each year of monitoring revisits. Management recommendations will be identified in the monitoring reports. If immediate action is needed to maintain population viability, project suggestions will be brought forth to the forest leadership team.

Monitoring reports will be stored at:
O:\NFS\LTBMU\Project\Monitoring\StatusTrend\Draba_asterophora LongTermMonitoring

Reports will also be posted to the external LTBMU website under "Publications" at:

http://www.fs.usda.gov/wps/portal/fsinternet/!ut/p/c4/04_SB8K8xLLM9MSSzPy8xBz9CP0os3gjAwhwtDDw9_AI8zPyhQoY6BdkOyoCAGixyPg!/?ss=110519&navtype=BROWSEBYSUBJECT&cid=FSM9_046480&navid=360000000000000&position=Feature*&ttype=detail&pname=Lake Tahoe Basin Mgt Unit- Maps & Publications

ASSESSMENT

The monitoring protocol will be assessed after initial data analysis is complete to weigh the information gained against time and resource requirements, and to determine the efficiency of the methods. Changes to the protocol, inclusion of additional sites, and/or suggestions for improvement will be considered.

PLANNING

Activity	Time	Notes
Monitoring visits		(Based on 10 hour day with 2 people)
1a, 1b, 1d, 1j (Freel Peak/Star Lake)	3 days	Multi-day backpack is best. Day 1: Hike to Star Lake & survey 1d in the afternoon. Day 2: Hike to 1a, survey, then hike to 1b and survey. Day 3: Survey 1j and then hike out.
2b, 2f (Heavenly Ski Area)	1 day	Very full day.
3b (Mt Rose)	1 day	
1b, 1e (Saucer Lake)	2 days	Overnight backpack. Day 1: Hike to Saucer Lake & survey 1b in the afternoon. Day 2: Hike to 1e, survey, then return and hike out.
Cup Lake (ENF)	1 day	
Mt Rose Ski Area (HTNF)	2 days	
Relay Peak (HTNF)	1 day	
Office work		(Based on 8 hour day 1 person)
Data entry	5 days	
Data analysis & Reporting	10 days	

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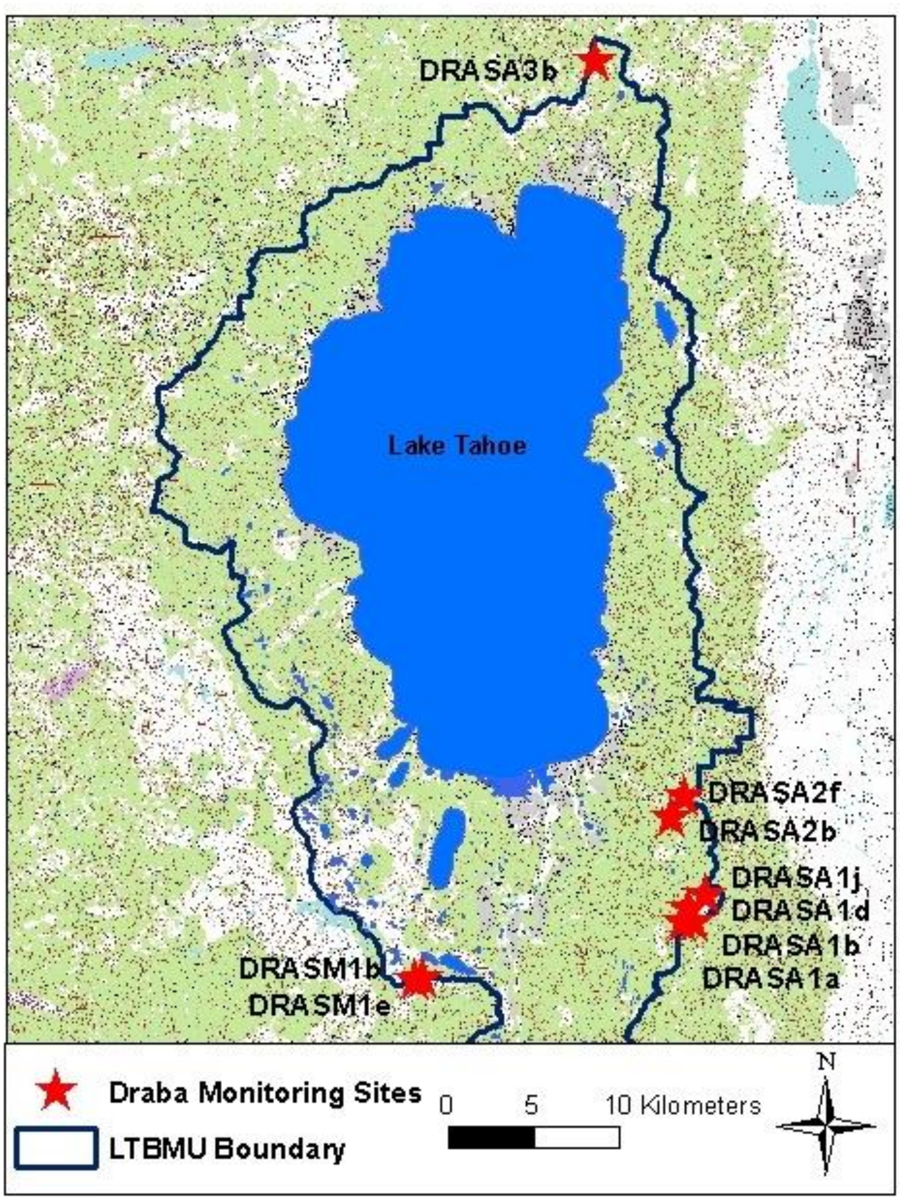
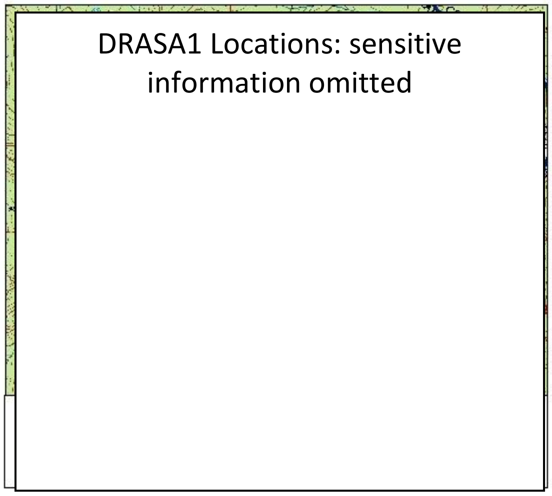
APPENDIX 1. Location maps of populations selected for long-term monitoring plots: a) general locations on the Lake Tahoe Basin Management Unit; b) general locations on the Humboldt-Toiyabe National Forest and Eldorado National Forest (planned 2012); c) DRASA 1a, 1b, 1d, and 1j (Freel Peak/Star Lake); d) DRASA 2b and 2f (Heavenly Ski Area); e) DRASA 3b (Mt. Rose); and f) DRASM 1b and 1e (Saucer Lake/Ralston Peak). Pages 18-20.



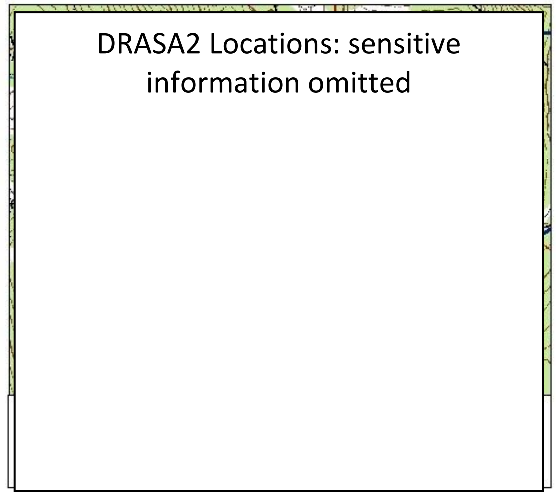
a)


DRASATam1
DRASARose2
DRASARose1
Lake Tahoe
DRASM_ENF
Draba Monitoring Sites
LTBMU Boundary
0 5 10 Kilometers
N

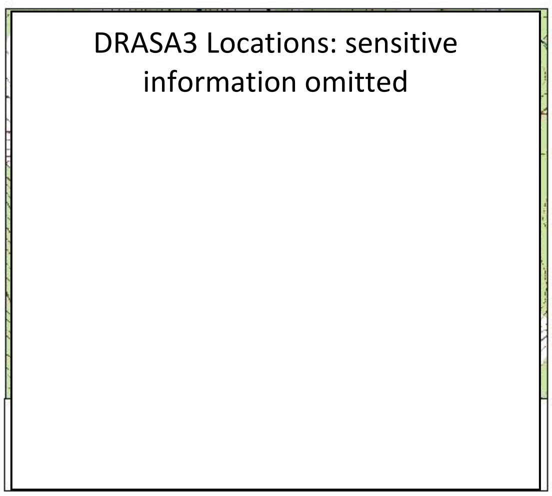
b)


DRASA1 Locations: sensitive information omitted

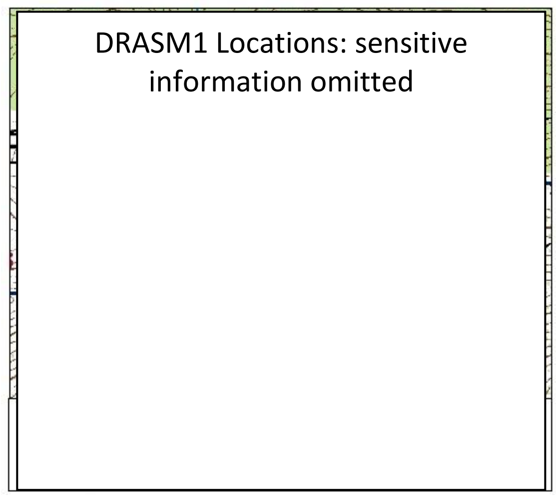
c)


DRASA2 Locations: sensitive information omitted

d)


DRASA3 Locations: sensitive information omitted

e)


DRASM1 Locations: sensitive information omitted

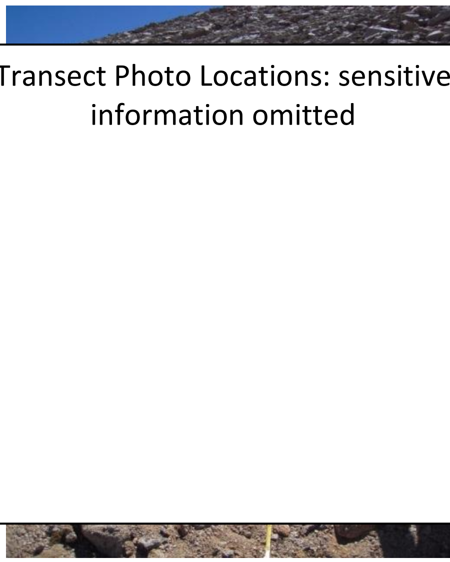
f)

APPENDIX 2. LTBMU transect descriptions including length, bearing (taken from 0m), side of transect for plots, endpoint UTMs (NAD83, Zone 10) and photographs taken from both transect endpoints. Diagram of transect locations at each site. Pages 21-38. (Appendix 3 provides additional information on the number of plots at each transect, side of transect for plots, plot ID#, and distance along transect.)

<u>DRASA1a, Transect 1</u>: 21.5m long, Bearing=135°, Plots on left side of transect

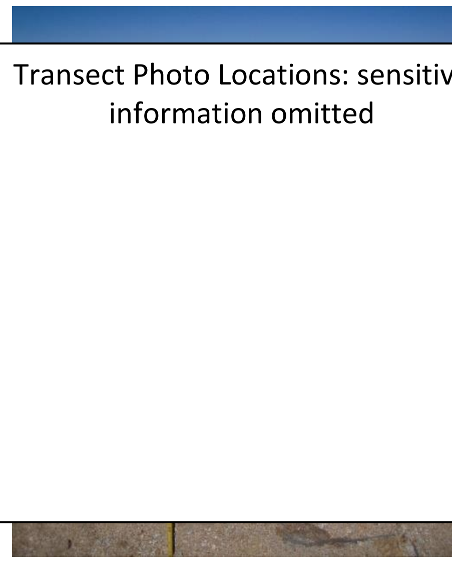
UTM Data: Sensitive information omitted

0m → 21.5m



Transect Photo Locations: sensitive information omitted

21.5m → 0m

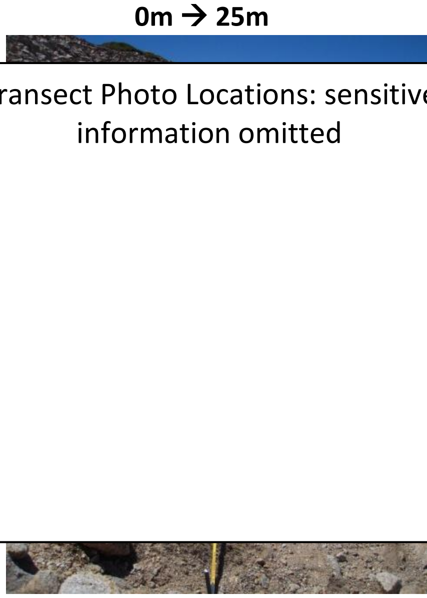


Transect Photo Locations: sensitive information omitted

<u>DRASA1a, Transect 2</u>: 25m long, Bearing=236°, Plots on left side of transect

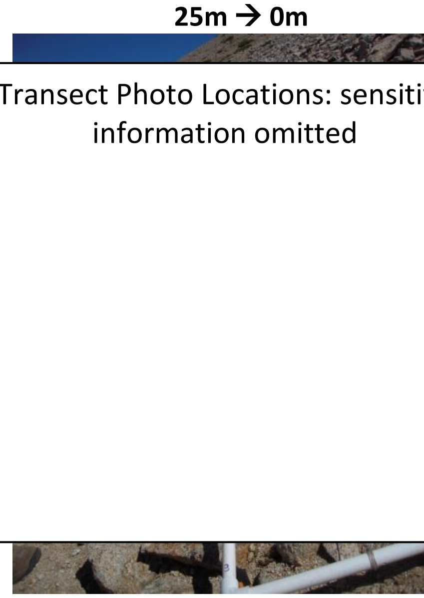
UTM Data: Sensitive information omitted

0m → 25m



Transect Photo Locations: sensitive information omitted

25m → 0m

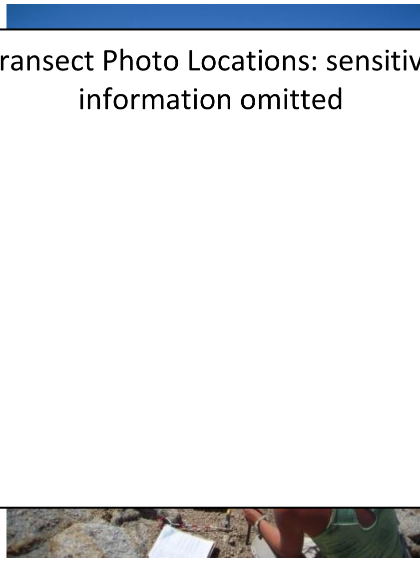


Transect Photo Locations: sensitive information omitted

<u>DRASA1a, Transect 3</u>: 25m long, Bearing=246°, Plots on left side of transect

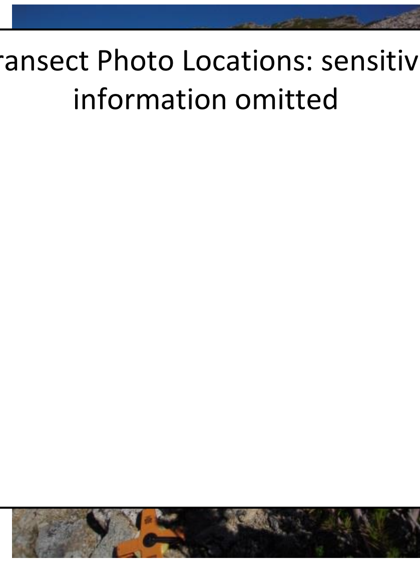
UTM Data: Sensitive information omitted

0m → 25m

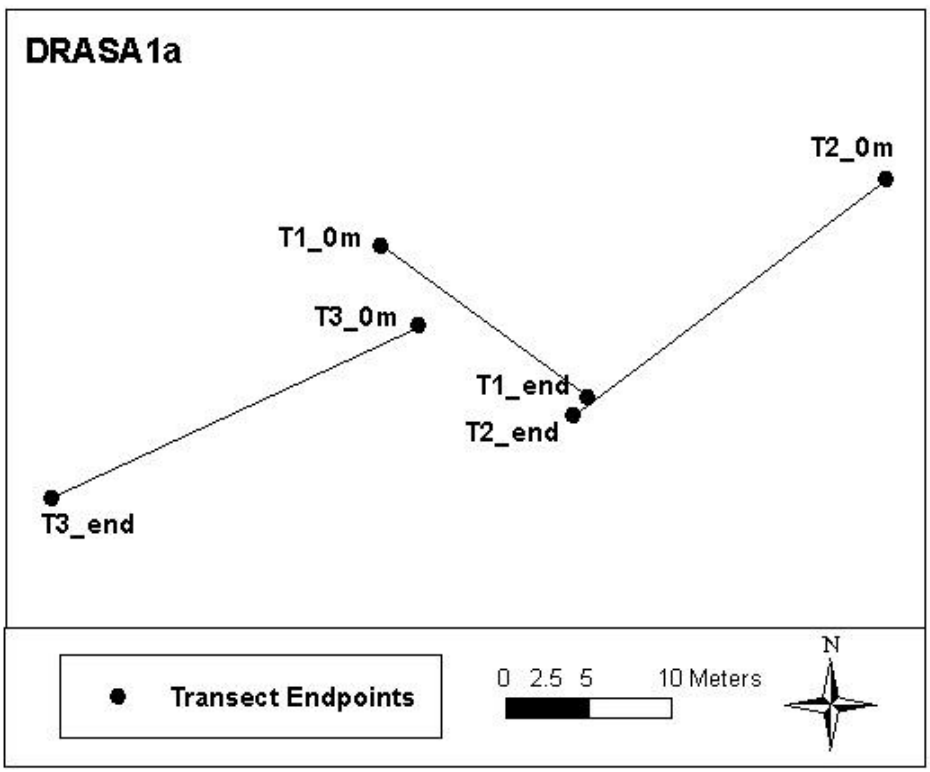


Transect Photo Locations: sensitive information omitted

25m → 0m



Transect Photo Locations: sensitive information omitted



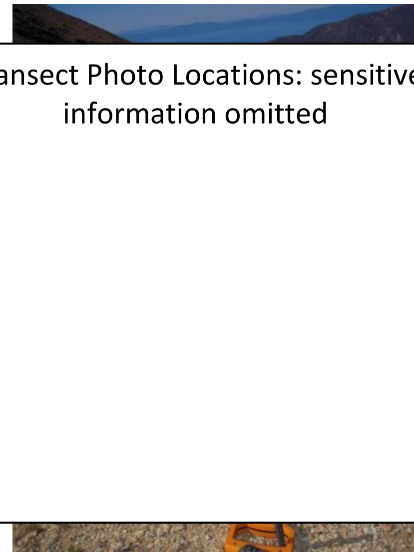
<u>DRASA1b, Transect 1</u>: 25m long, Bearing=164°, Plots on left side of transect

UTM Data: Sensitive information omitted

0m → 25m

Transect Photo Locations: sensitive information omitted

25m → 0m

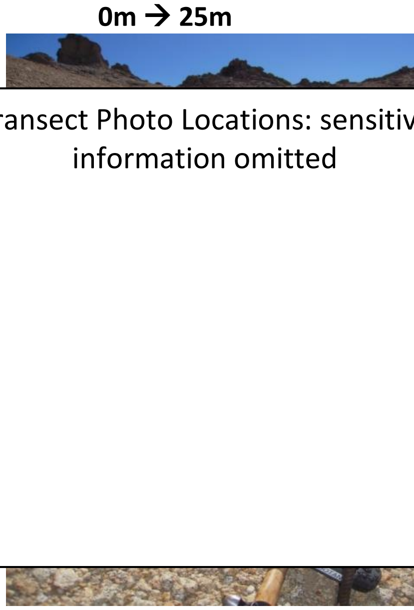


Transect Photo Locations: sensitive information omitted

<u>DRASA1b, Transect 2</u>: 25m long, Bearing=243°, Plots on left side of transect

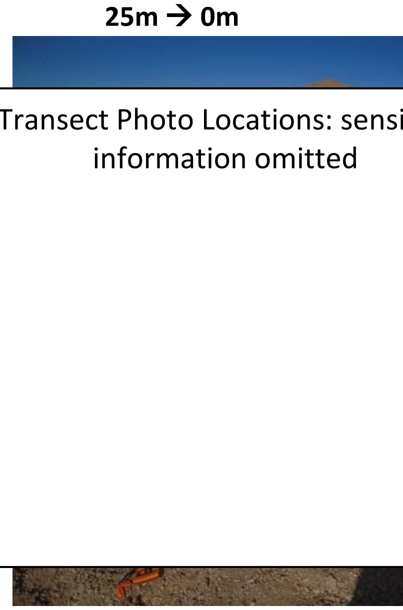
UTM Data: Sensitive information omitted

0m → 25m



Transect Photo Locations: sensitive information omitted

25m → 0m

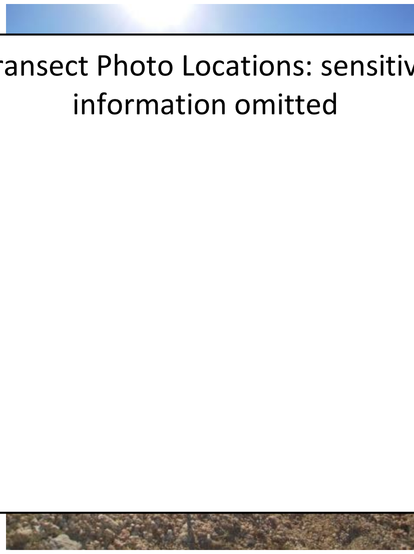


Transect Photo Locations: sensitive information omitted

<u>DRASA1b, Transect 3</u>: 30m long, Bearing=261°, Plots on left side of transect

UTM Data: Sensitive information omitted

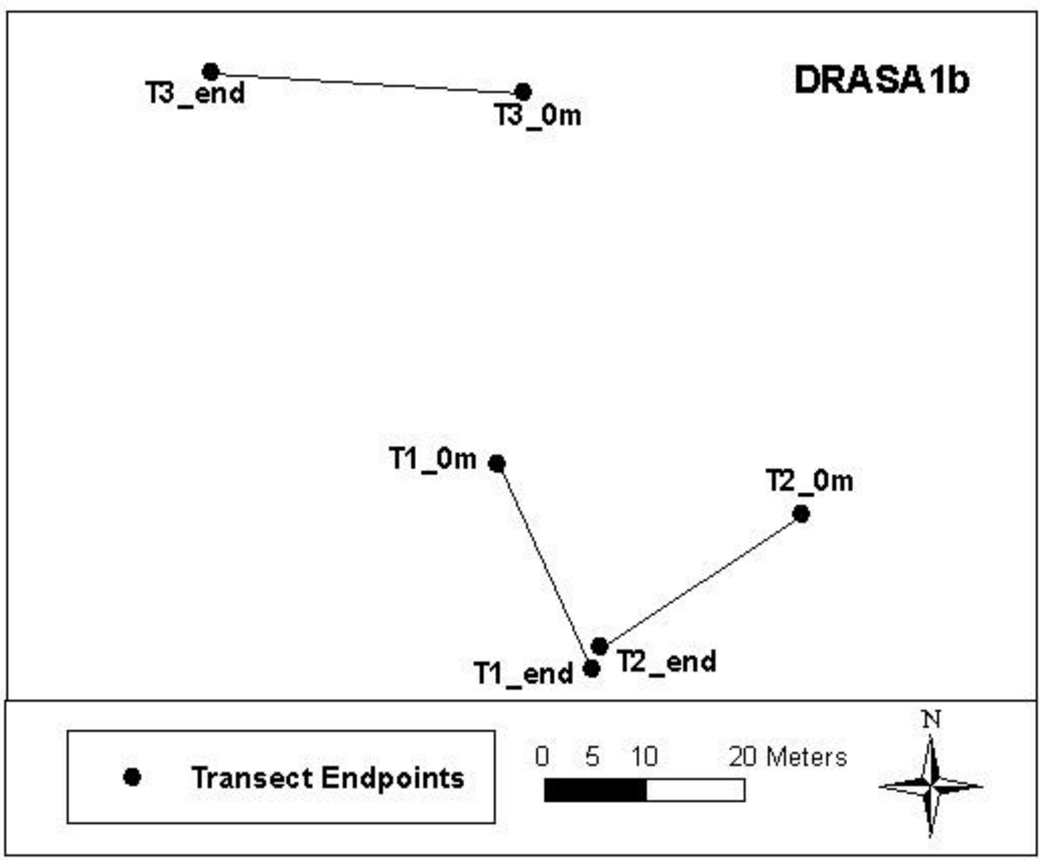
0m → 30m



Transect Photo Locations: sensitive information omitted

30m → 0m

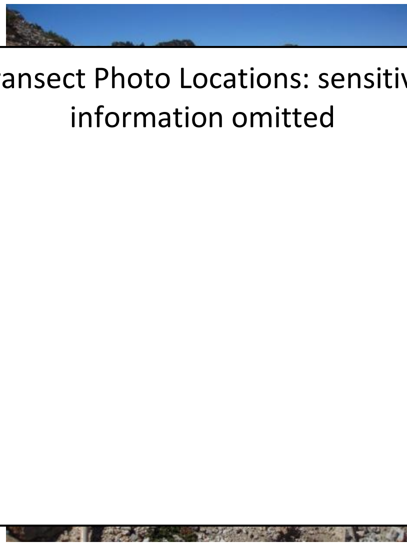
Photo missing



DRASA1d, Transect 1: 25m long, Bearing=272°, Plots on left side of transect

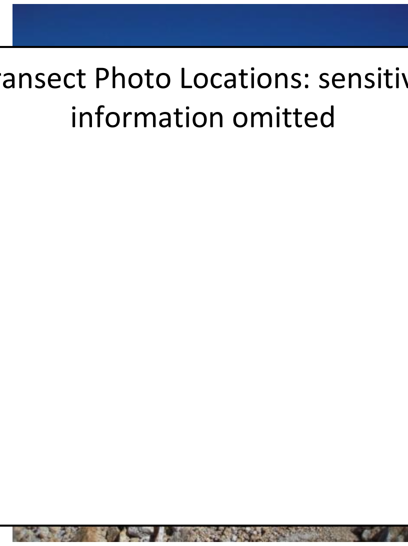
UTM Data: Sensitive information omitted

0m → 25m



Transect Photo Locations: sensitive information omitted

25m → 0m

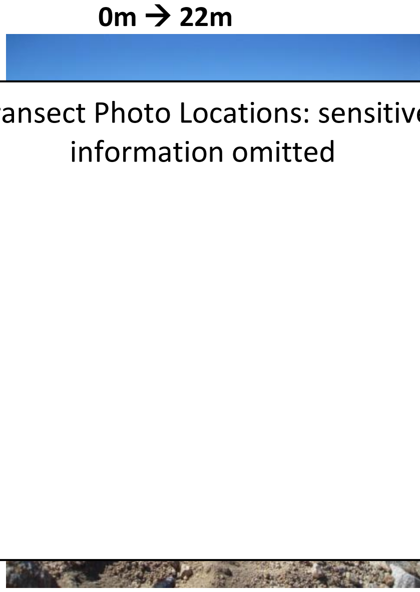


Transect Photo Locations: sensitive information omitted

DRASA1d, Transect 2: 22m long, Bearing=278°, Plots on left side of transect

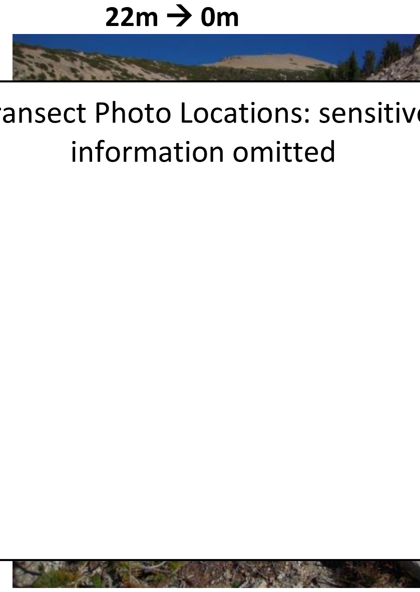
UTM Data: Sensitive information omitted

0m → 22m



Transect Photo Locations: sensitive information omitted

22m → 0m

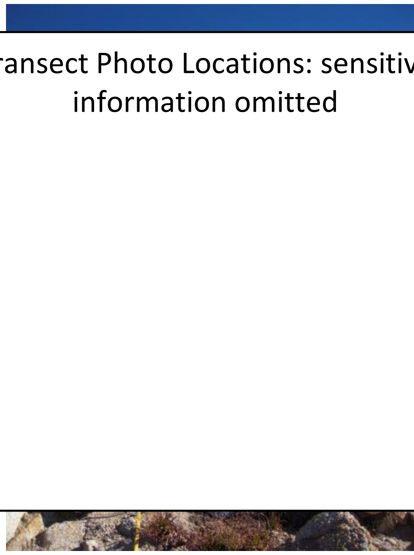


Transect Photo Locations: sensitive information omitted

<u>DRASA1d, Transect 3</u>: 25m long, Bearing=171°, Plots on right side of transect

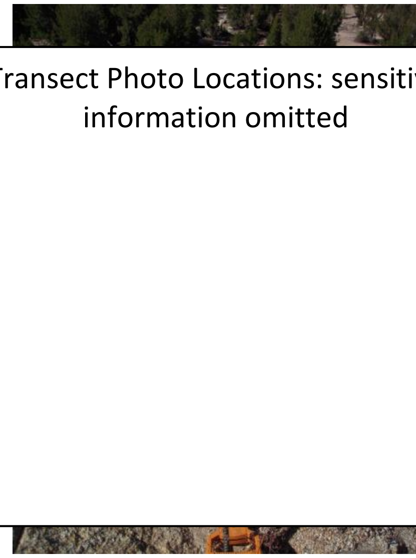
UTM Data: Sensitive information omitted

0m → 25m

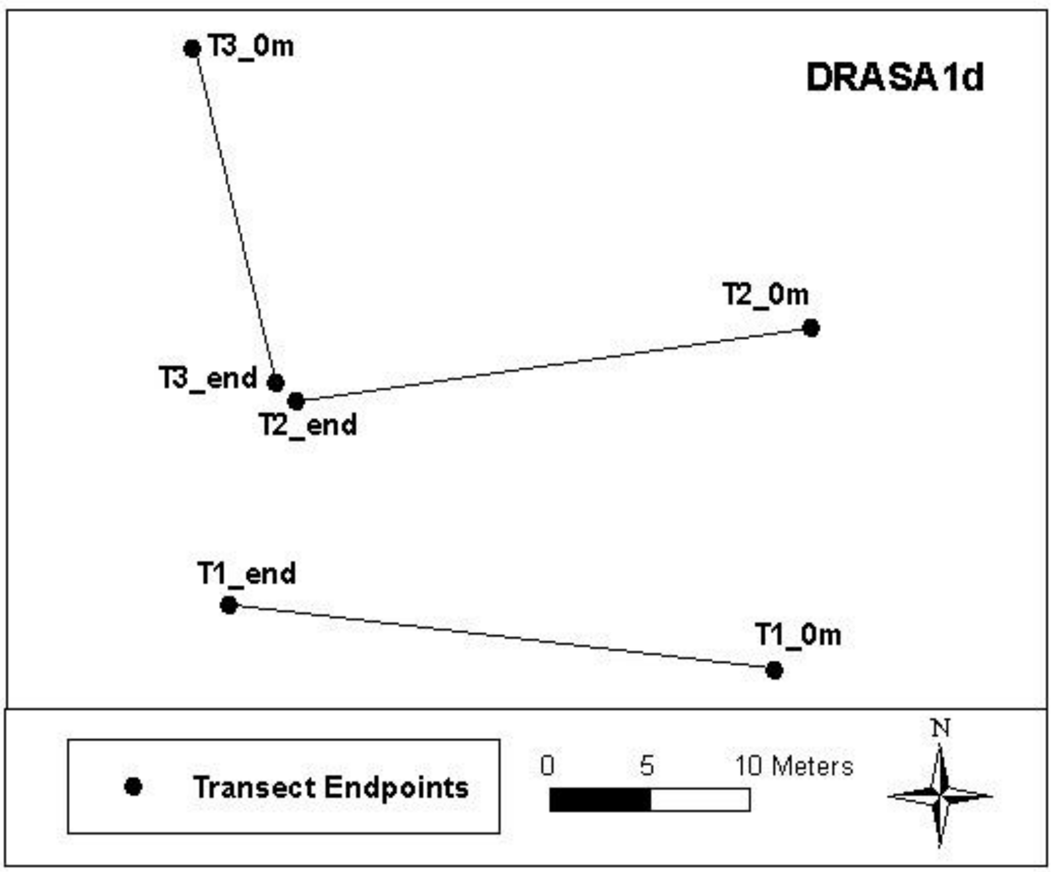


Transect Photo Locations: sensitive information omitted

25m → 0m



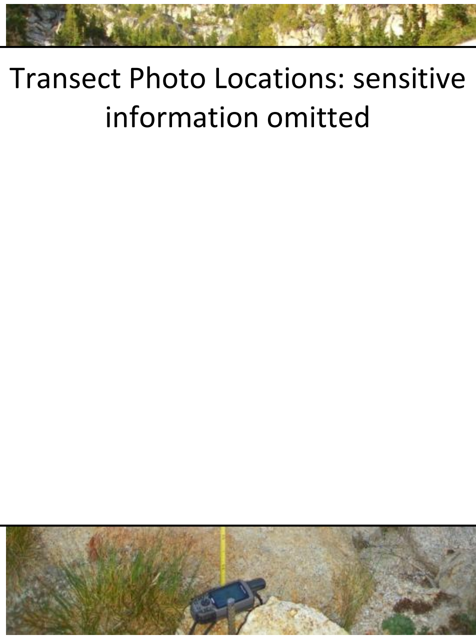
Transect Photo Locations: sensitive information omitted



<u>DRASA1j, Transect 1</u>: 25m long, Bearing=232°, Plots on right side of transect

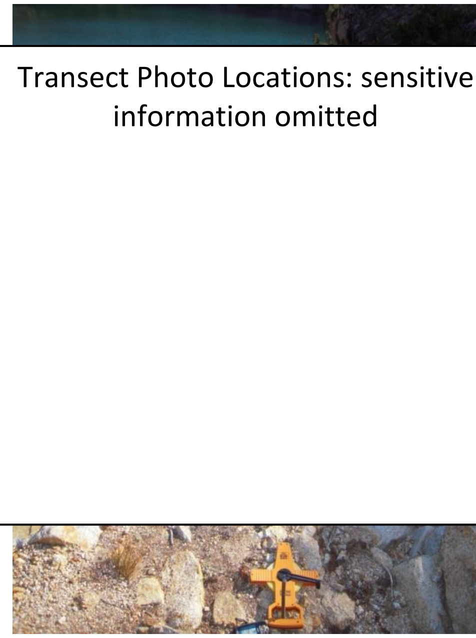
UTM Data: Sensitive information omitted

0m → 25m



Transect Photo Locations: sensitive information omitted

25m → 0m

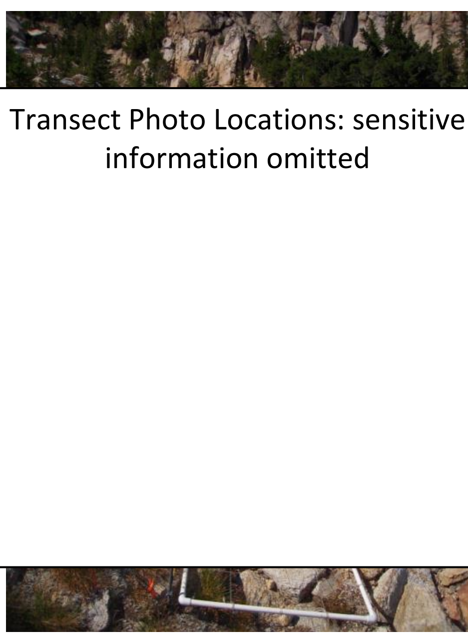


Transect Photo Locations: sensitive information omitted

<u>DRASA1j, Transect 2</u>: 20m long, Bearing=231°, Plots on right side of transect

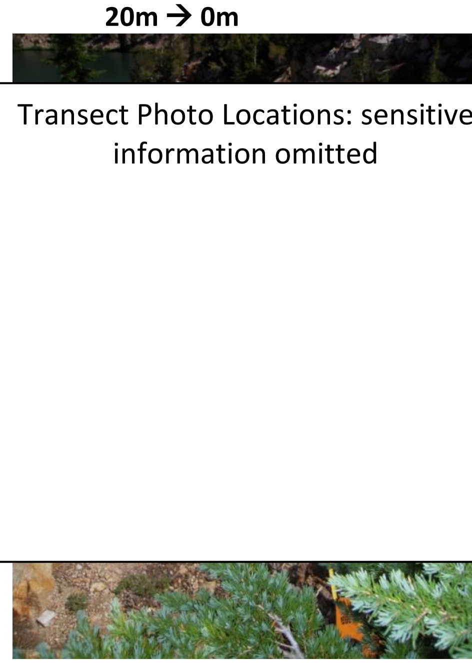
UTM Data: Sensitive information omitted

0m → 20m

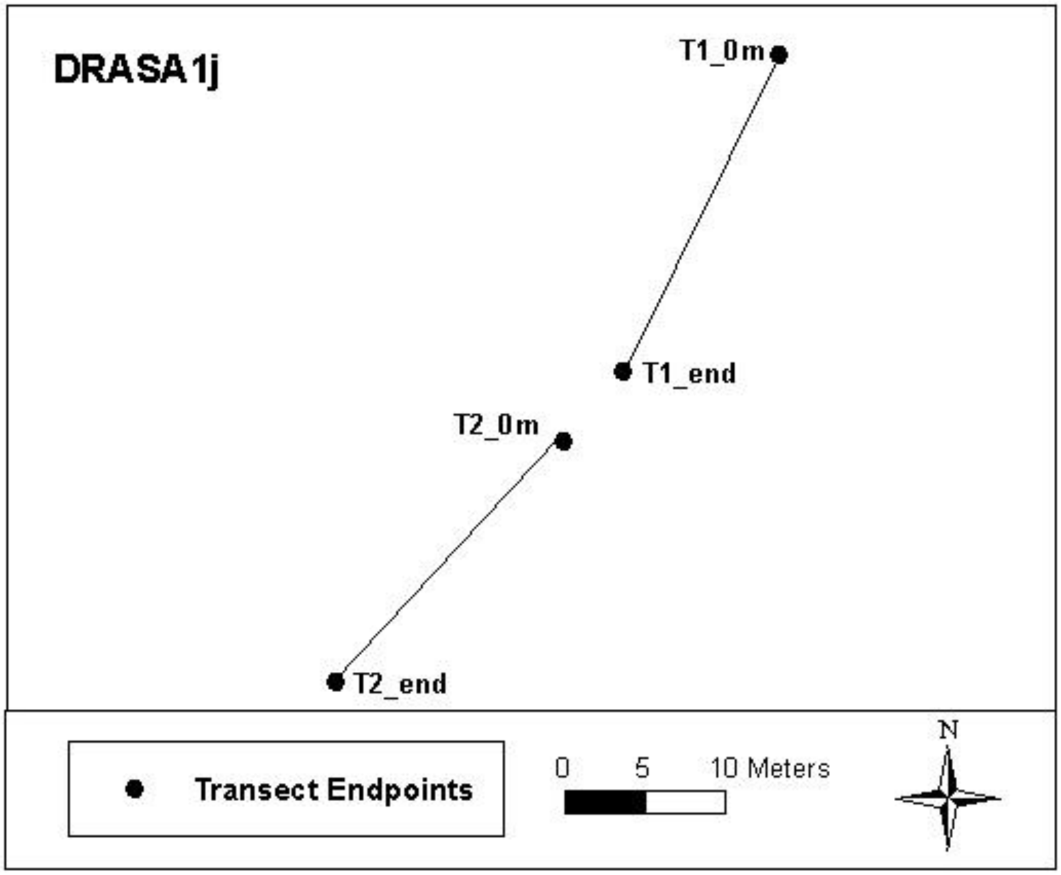


Transect Photo Locations: sensitive information omitted

20m → 0m



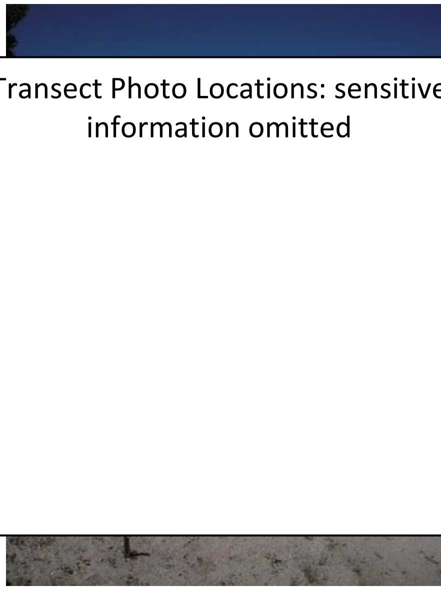
Transect Photo Locations: sensitive information omitted


DRASA1j
T1_0m
T1_end
T2_0m
T2_end
Transect Endpoints
0
5
10 Meters
N

<u>DRASA2b, Transect 1</u>: 13m long, Bearing=271°, Plots on left side of transect

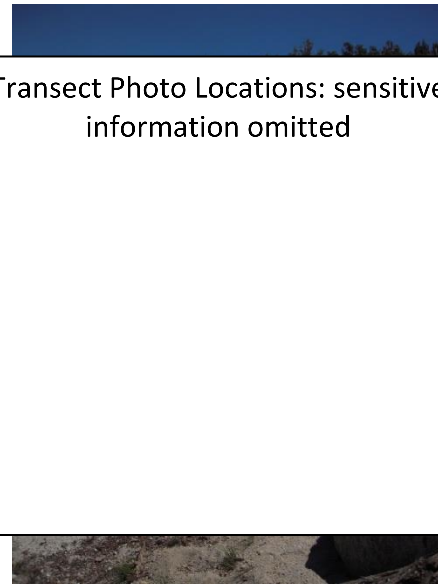
UTM Data: Sensitive information omitted

0m → 13m



Transect Photo Locations: sensitive information omitted

13**m → 0m**

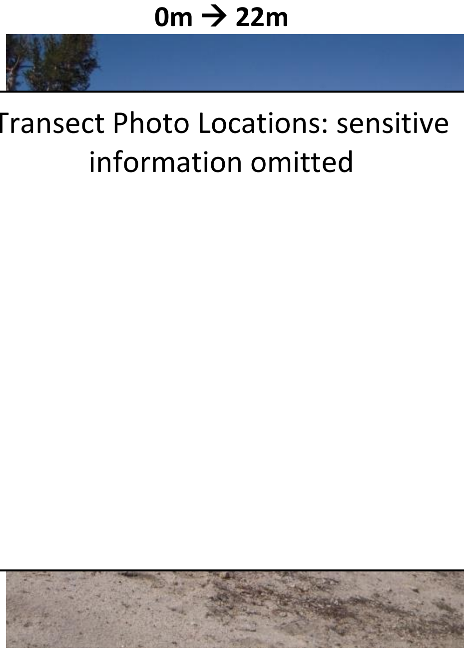


Transect Photo Locations: sensitive information omitted

<u>DRASA2b, Transect 2</u>: 22m long, Bearing=262°, Plots on left side of transect

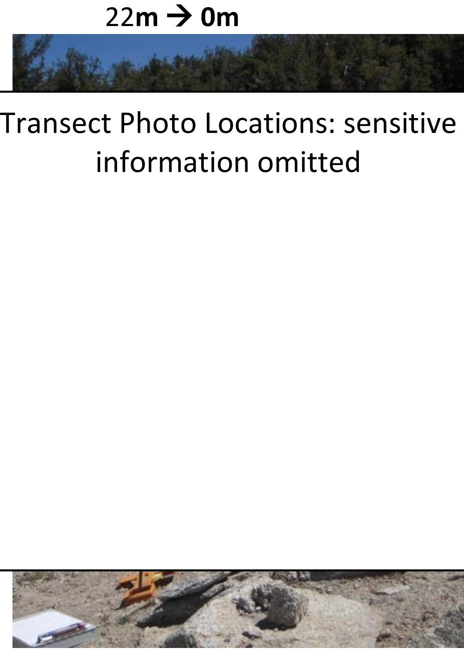
UTM Data: Sensitive information omitted

0m → 22m



Transect Photo Locations: sensitive information omitted

22**m → 0m**

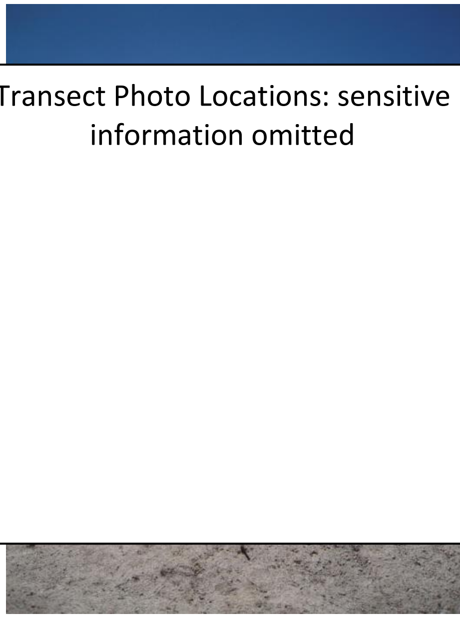


Transect Photo Locations: sensitive information omitted

DRASA2b, Transect 3: 24m long, Bearing=164°, Plots on right side of transect

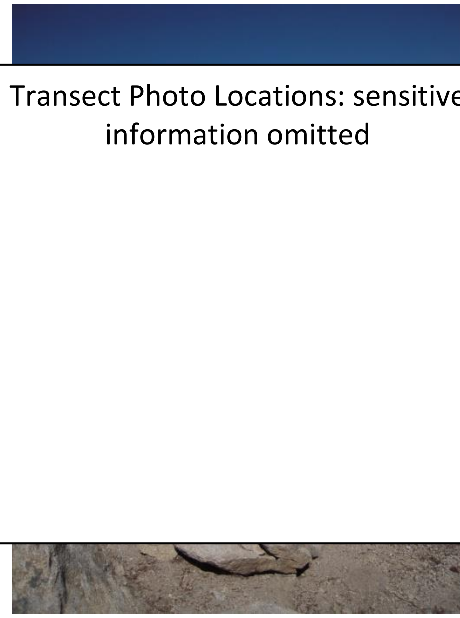
UTM Data: Sensitive information omitted

0m → 24m

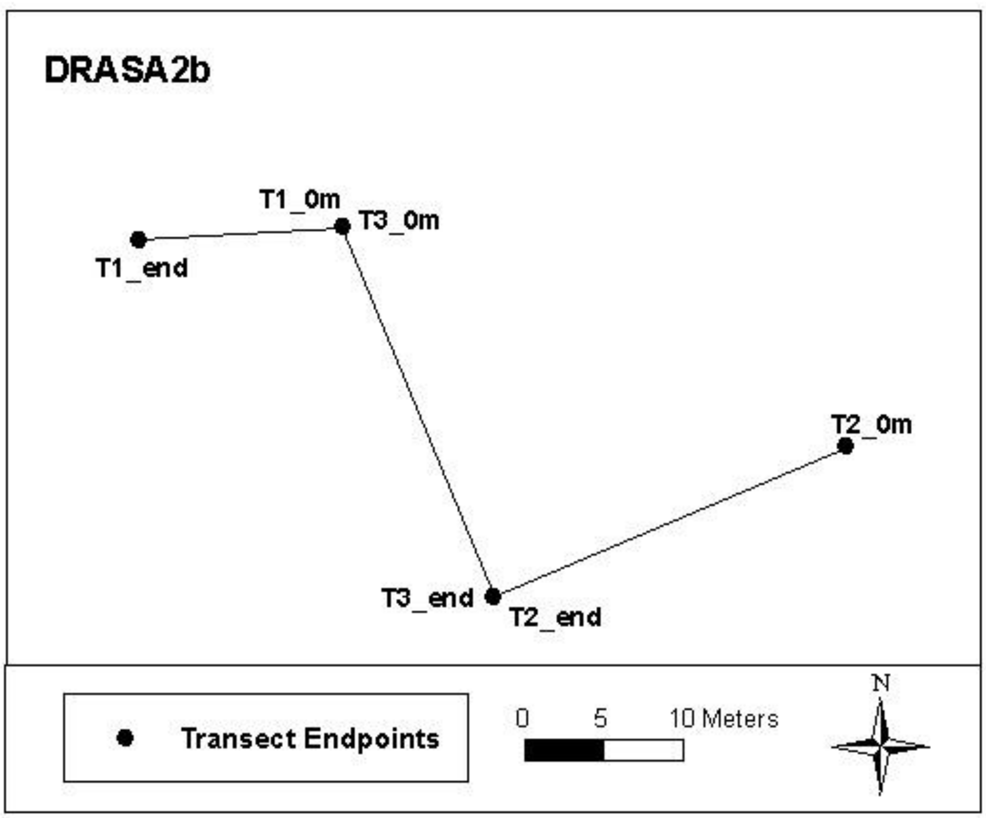


Transect Photo Locations: sensitive information omitted

24m → 0m



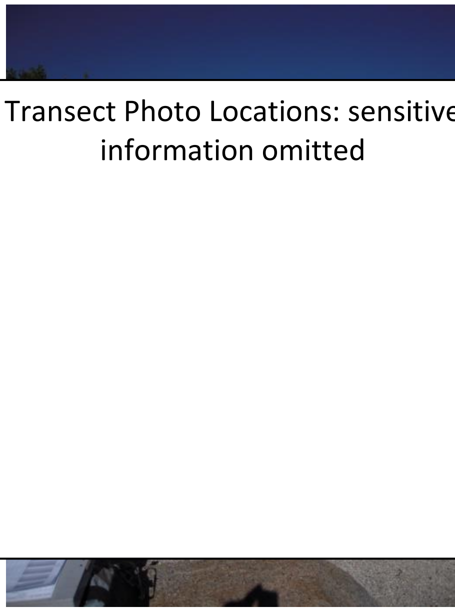
Transect Photo Locations: sensitive information omitted



<u>DRASA2f, Transect 1</u>: 19m long, Bearing=275°, Plots on left side of transect

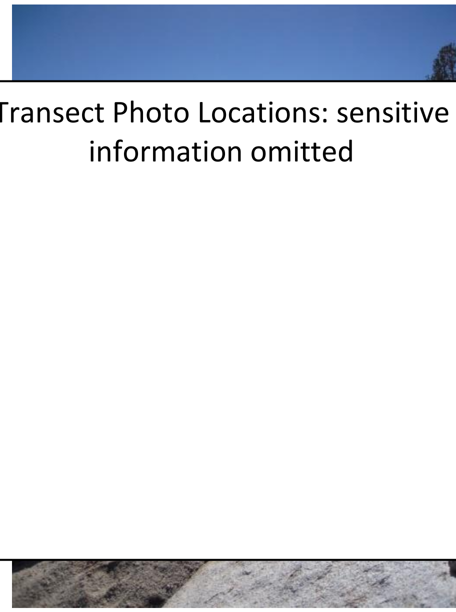
UTM Data: Sensitive information omitted

0m → 19m



Transect Photo Locations: sensitive information omitted

19m → 0m

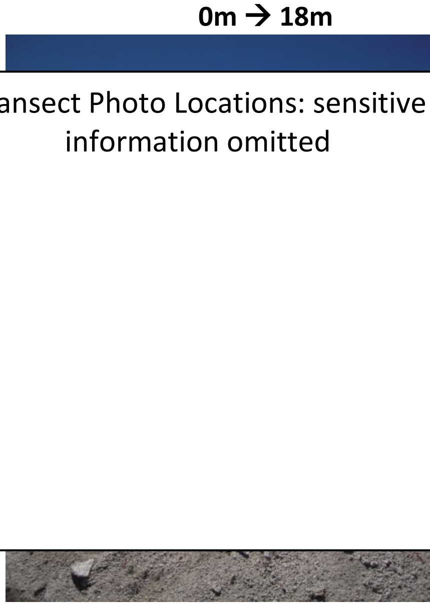


Transect Photo Locations: sensitive information omitted

<u>DRASA2f, Transect 2</u>: 18m long, Bearing=346°, Plots on left side of transect

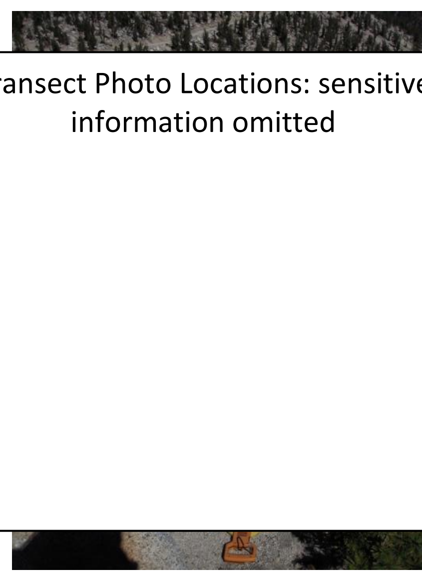
UTM Data: Sensitive information omitted

0m → 18m



Transect Photo Locations: sensitive information omitted

18m → 0m

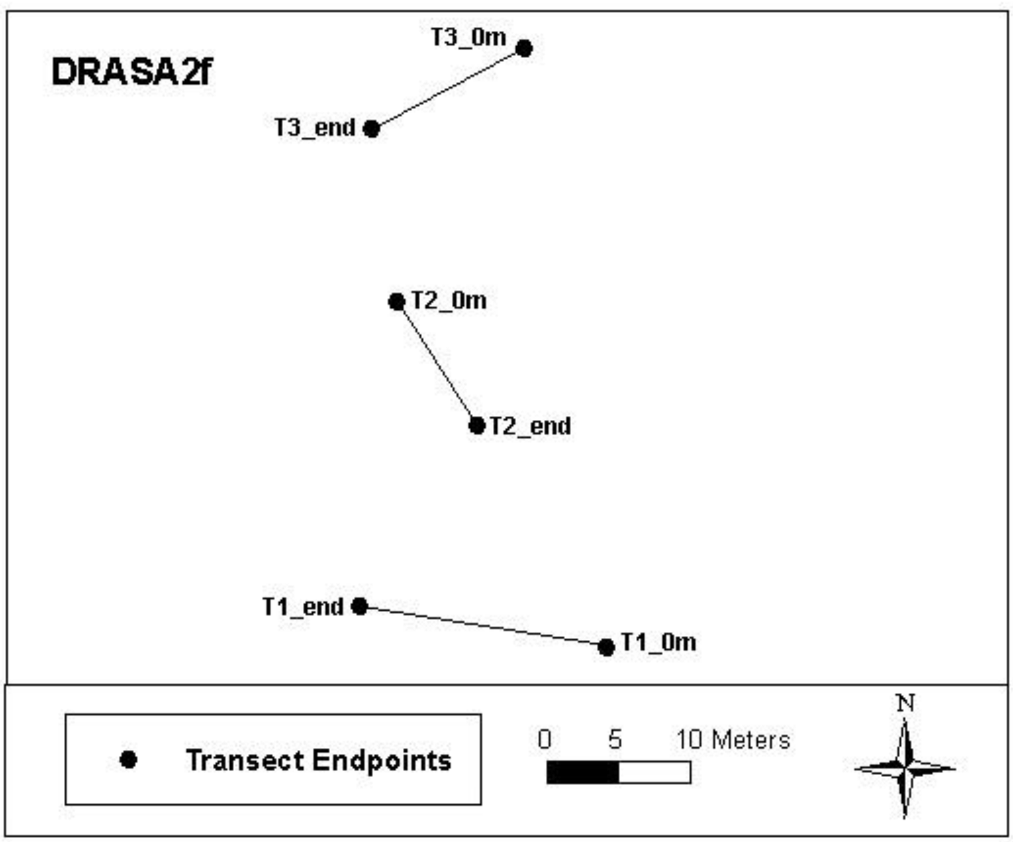


Transect Photo Locations: sensitive information omitted

<u>DRASA2f, Transect 3</u>: 16m long, Bearing=274°, Plots on left side of transect

UTM Data: Sensitive information omitted

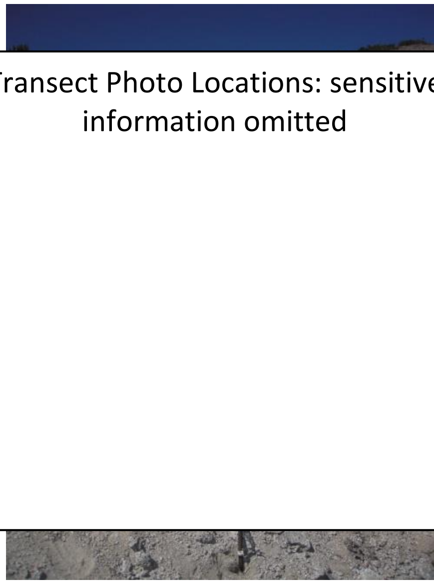
0m → 16m	**16m → 0m**
No photo taken	No photo taken



<u>DRASA3b, Transect 1</u>: 30m long, Bearing=263°, Plots on left side of transect

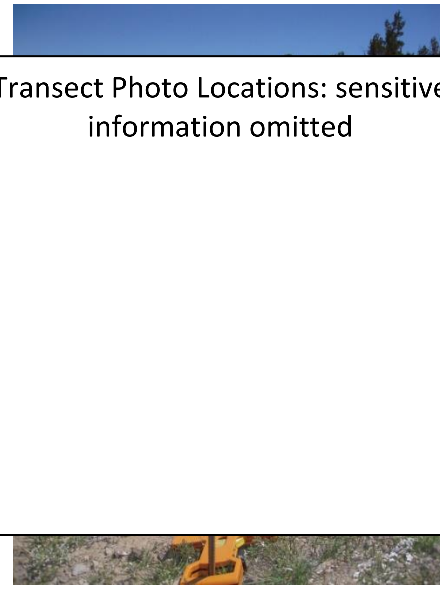
UTM Data: Sensitive information omitted

0m → 30m



Transect Photo Locations: sensitive information omitted

30m → 0m

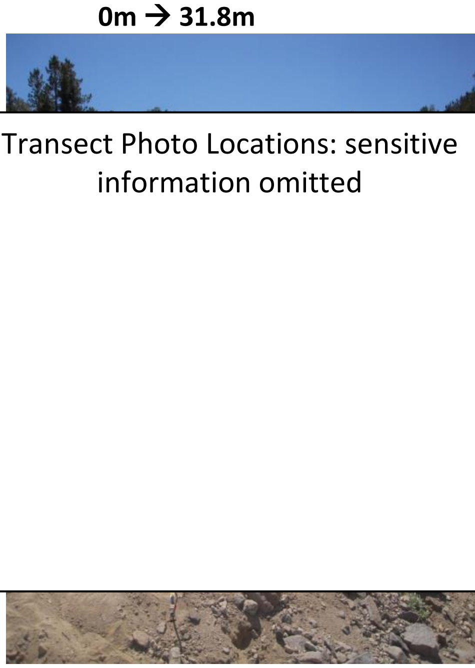


Transect Photo Locations: sensitive information omitted

<u>DRASA3b, Transect 2</u>: 31.8m long, Bearing=214°, Plots on left side of transect

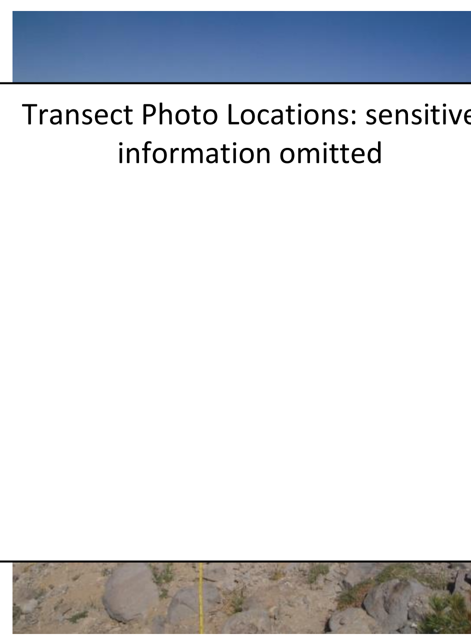
UTM Data: Sensitive information omitted

0m → 31.8m

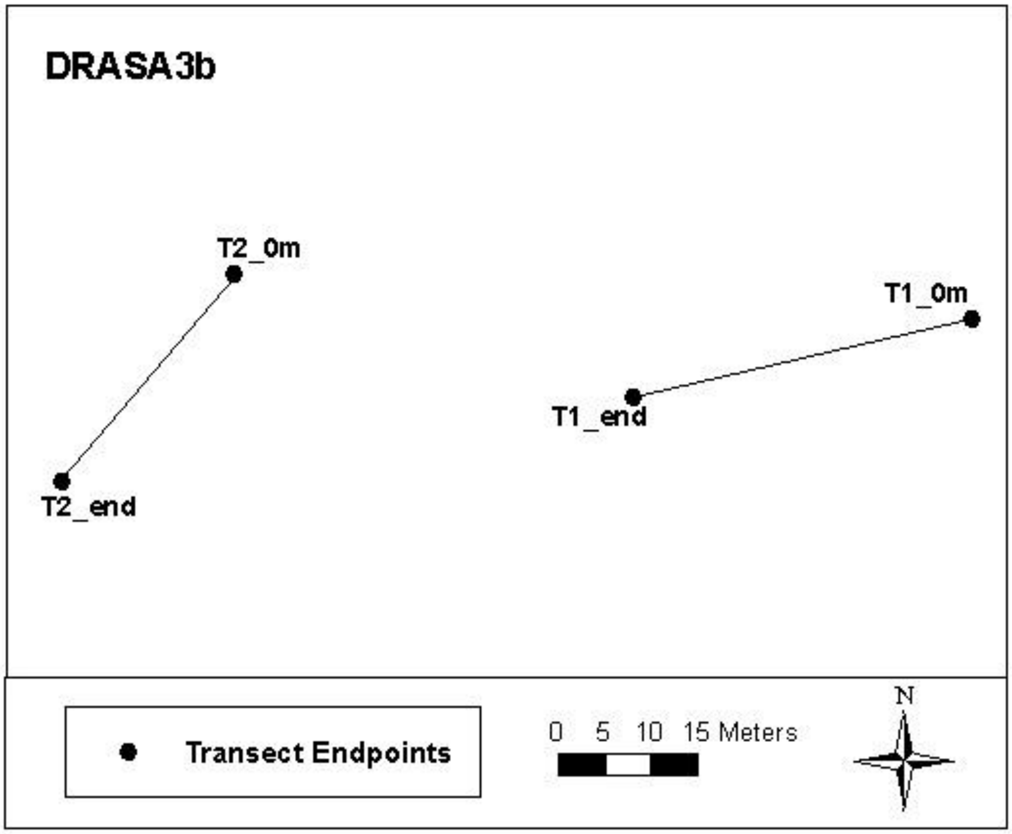


Transect Photo Locations: sensitive information omitted

31.8m → 0m



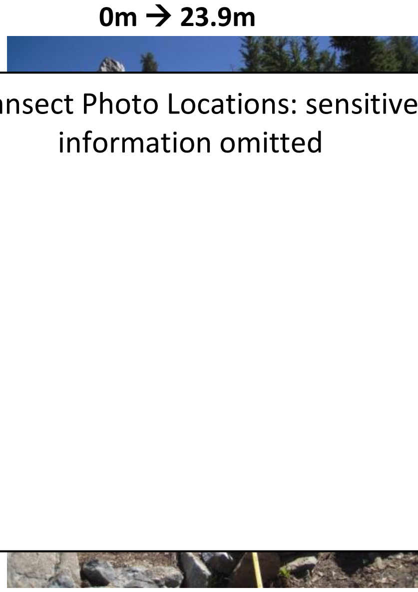
Transect Photo Locations: sensitive information omitted



<u>DRASM 1b, Transect 1</u>: 23.9m long, Bearing=179°, Plots on right side of transect

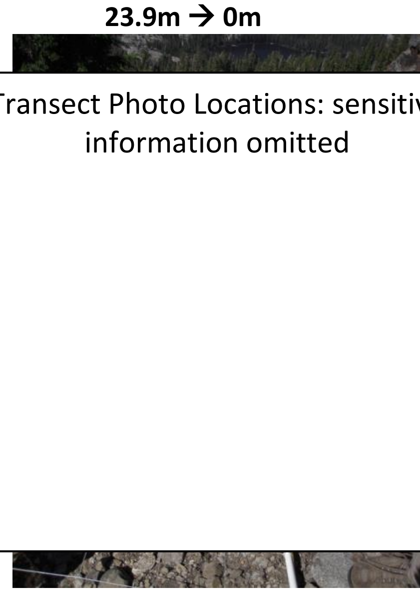
UTM Data: Sensitive information omitted

0m → 23.9m



Transect Photo Locations: sensitive information omitted

23.9m → 0m

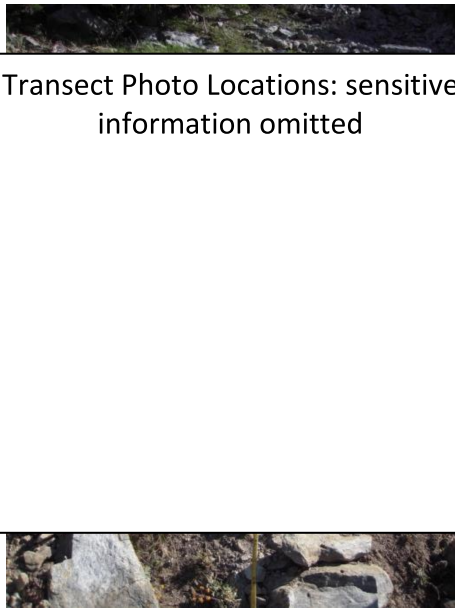


Transect Photo Locations: sensitive information omitted

DRASM1b, Transect 2: four “sub-transects” with same 0m point but different bearings, Plots on left side of transect, see diagram of transect layout for clarification

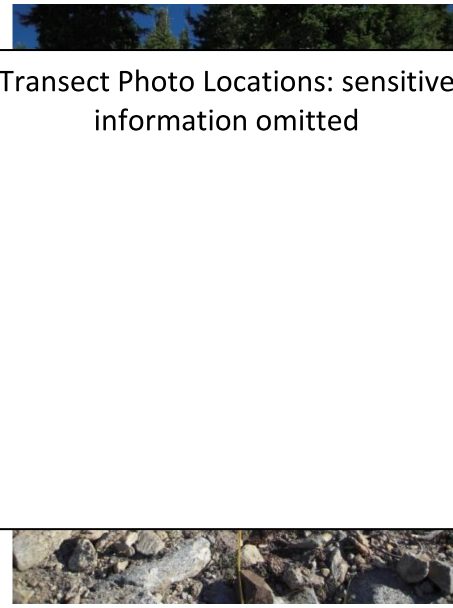
UTM Data: Sensitive information omitted

2a: 188°, 0m → 6m



Transect Photo Locations: sensitive information omitted

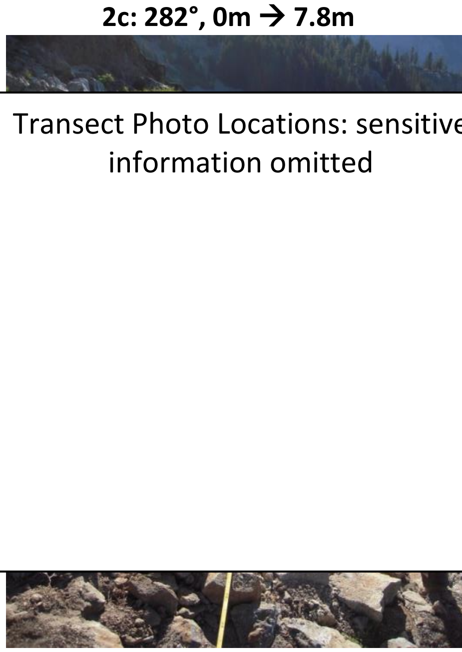
2b: 182°, 0m → 6.5m



Transect Photo Locations: sensitive information omitted

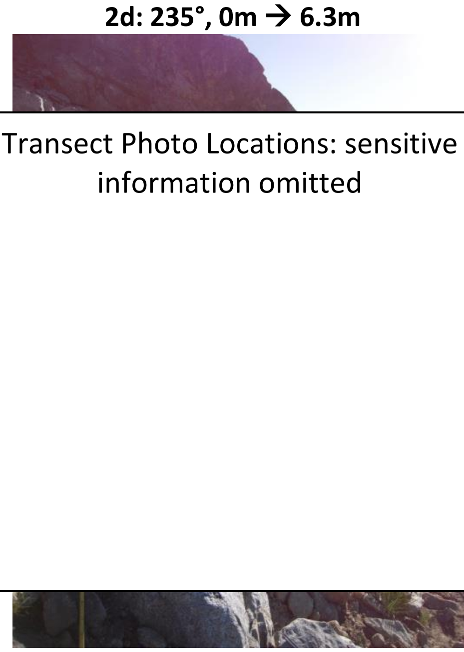
DRASM1b, Transect 2: continued…

2c: 282°, 0m → 7.8m

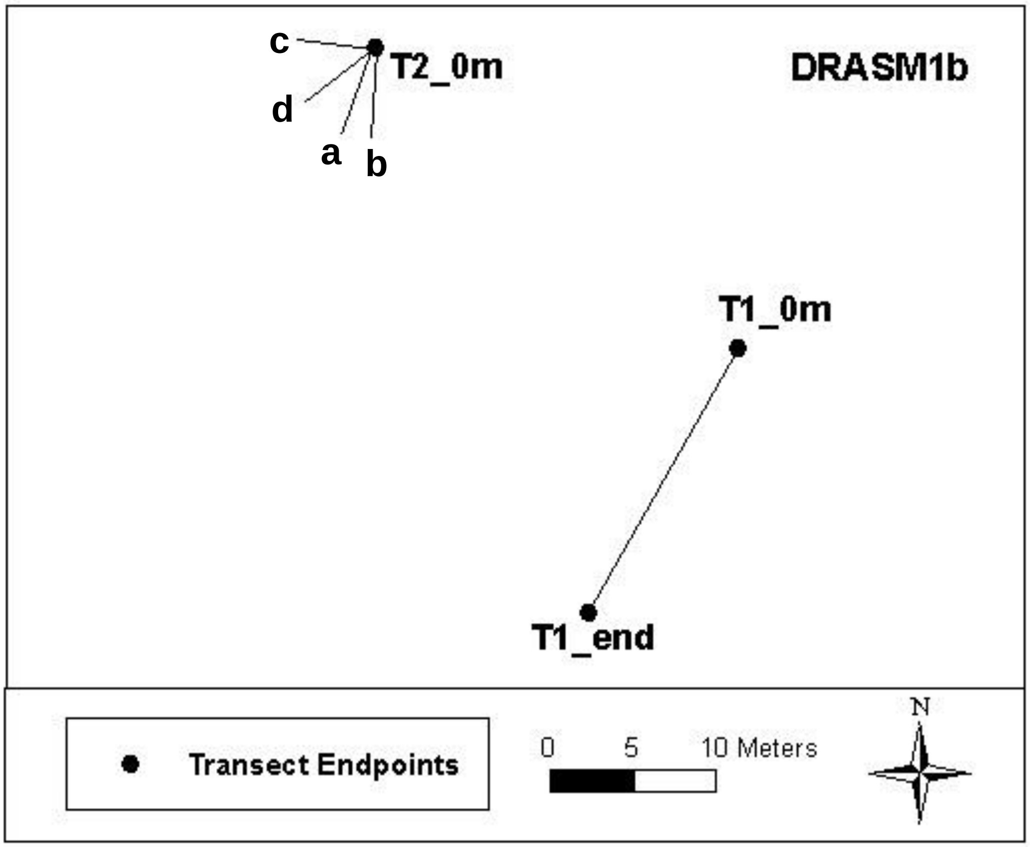


Transect Photo Locations: sensitive information omitted

2d: 235°, 0m → 6.3m



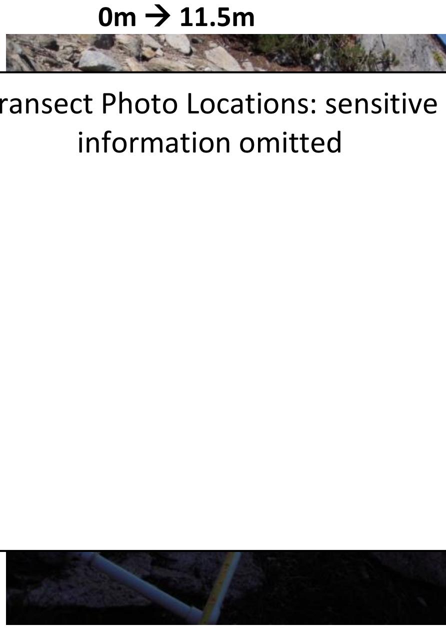
Transect Photo Locations: sensitive information omitted



<u>DRASM 1e Transect 1</u>: 11.5m long, Bearing=280°, Plots on left side of transect

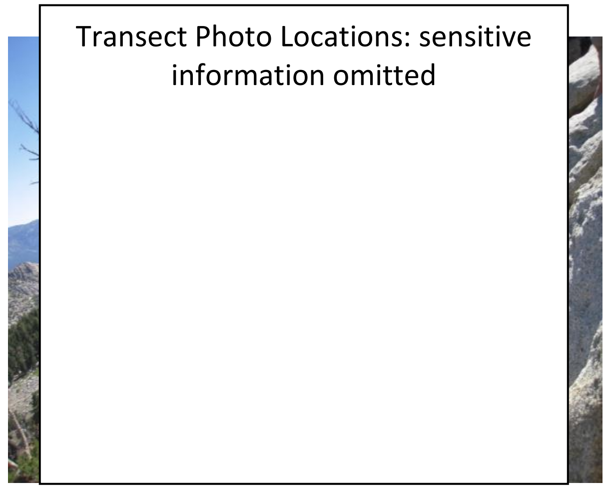
UTM Data: Sensitive information omitted

0m → 11.5m



Transect Photo Locations: sensitive information omitted

11.5m → 0m

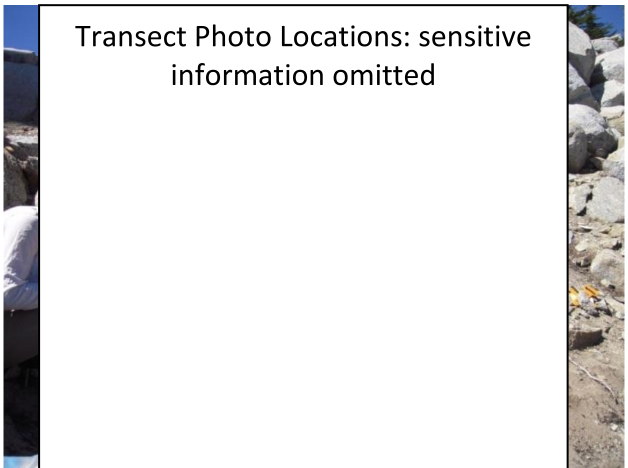


Transect Photo Locations: sensitive information omitted

<u>DRASM 1e Transect 2</u>: 3m long, Bearing=285°, Plots on left side of transect

UTM Data: Sensitive information omitted

Overall shot

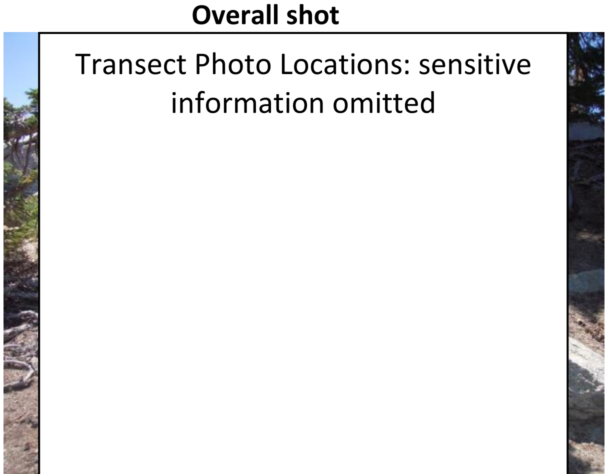


Transect Photo Locations: sensitive information omitted

<u>DRASM 1e Transect 3</u>: 3m long, Bearing=298°, Plots on left side of transect

UTM Data: Sensitive information omitted

Overall shot

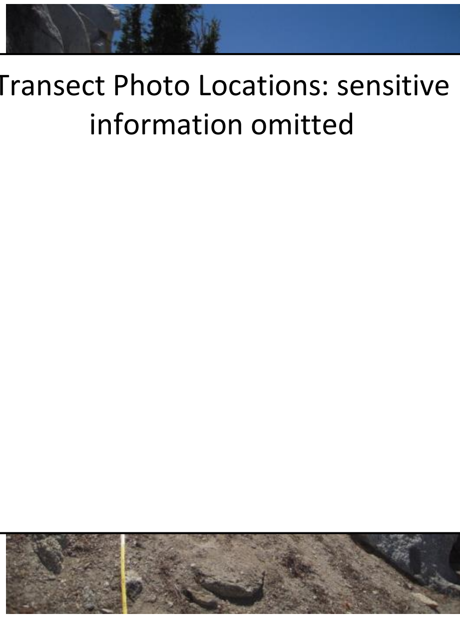


Transect Photo Locations: sensitive information omitted

<u>DRASM 1e Transect 4</u>: 18m long, Bearing=190°, Plots on left side of transect

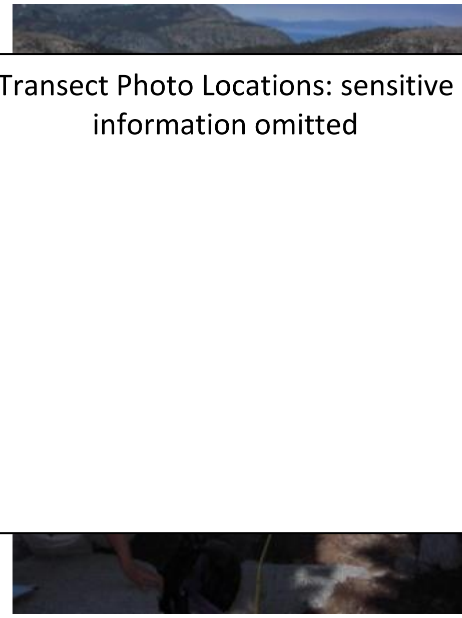
UTM Data: Sensitive information omitted

0m → 18m

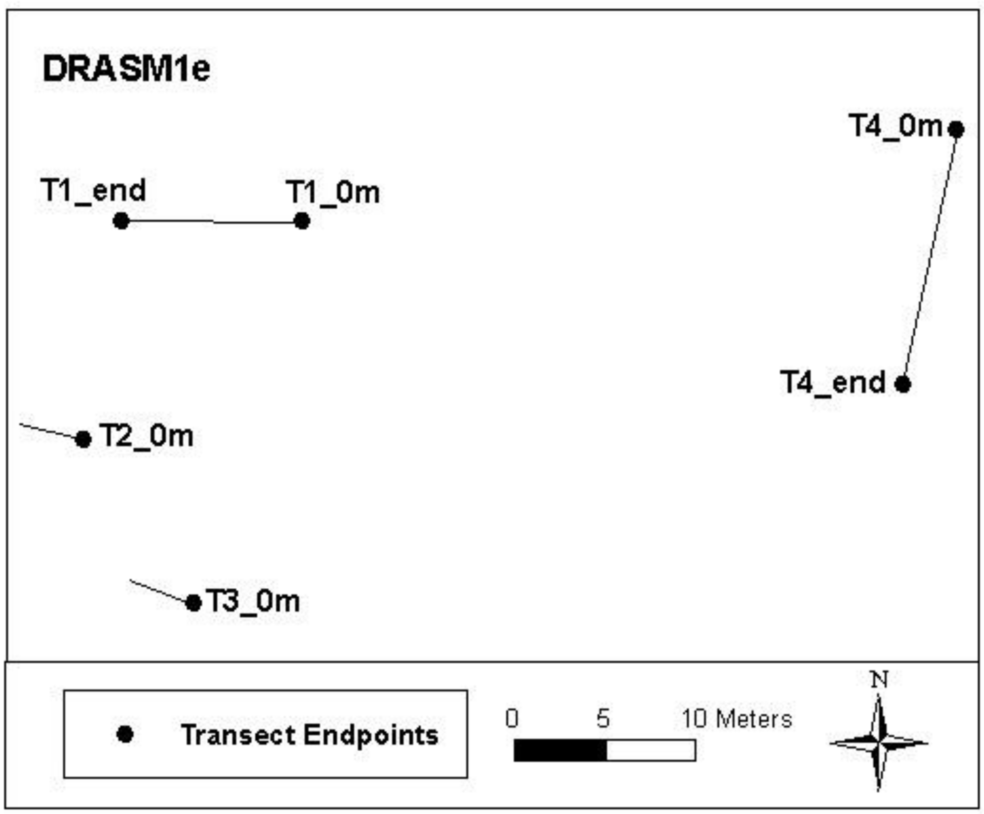


Transect Photo Locations: sensitive information omitted

18m → 0m



Transect Photo Locations: sensitive information omitted



APPENDIX 3. Number of plots at each LTBMU transect, side of transect for plots (when viewed from 0m), plot ID#, and distance along transect. "Distance" is the point on the transect tape where the lower left corner of the plot should be placed. Pages 39-43.

DRASA 1a (20 plots)

Transect 1 (8 plots, Left Side)

Plot ID#	Distance (m)
151	1
152	2
153	4
154	9
155	11
156	16
157	19
158	20

Transect 2 (7 plots, Left Side)

Plot ID#	Distance (m)
159	3
160	5
161	8
162	10
163	21
164	23
165	24

Transect 3 (5 plots, Left Side)

Plot ID#	Distance (m)
166	4
167	7
168	11
169	14
170	23

DRASA 1b (20 plots)

Transect 1 (7 plots, Left Side)

Plot ID#	Distance (m)
171	2
172	5
173	7
174	10
175	16
176	21
177	23

Transect 2 (7 plots, Left Side)

Plot ID#	Distance (m)
178	2
179	5
180	10
181	12
182	17
183	21
184	23

Transect 3 (6 plots, Left Side)

Plot ID#	Distance (m)
185	1
186	4
187	8
188	15
189	26
190	27

DRASA 1d (20 plots)

Transect 1 (7 plots, Left Side)

Plot ID#	Distance (m)
131	3
132	7
133	9
134	13
135	14
136	16
137	17

Transect 2 (7 plots, Left Side)

Plot ID#	Distance (m)
138	1
139	4
140	5
141	17
142	18
143	20
144	21

Transect 3 (6 plots, Right Side)

Plot ID#	Distance (m)
145	2
146	12
147	13
148	16
149	21
150	22

DRASA 1j (14 plots)

Transect 1 (7 plots, Right Side)

Plot ID#	Distance (m)
191	0
192	6
193	12
194	16
195	19
196	21
197	22

Transect 2 (7 plots, Right Side)

Plot ID#	Distance (m)
198	0
199	2
200	3
201	6
202	8
203	9
204	12

DRASA 2b (19 plots)

Transect 1 (4 plots, Left Side)

Plot ID#	Distance (m)
19	2
20	3
21	6
22	12

Transect 2 (9 plots, Left Side)

Plot ID#	Distance (m)
23	1
24	2
25	5
26	6
27	9
28	12
29	16
30	17
31	19

Transect 3 (6 plots, Right Side)

Plot ID#	Distance (m)
32	2
33	4
34	9
35	12
36	14
37	23

DRASA 2f (20 plots)

Transect 1 (8 plots, Left Side)

Plot ID#	Distance (m)
38	2
39	4
40	6
41	10
42	11
43	14
44	17
45	18

Transect 2 (6 plots, Left Side)

Plot ID#	Distance (m)
46	1
47	3
48	4
49	10
50	13
51	16

Transect 3 (6 plots, Left Side)

Plot ID#	Distance (m)
52	1
53	2
54	6
55	9
56	12
57	13

DRASA 3b (20 plots)

Transect 1 (10 plots, Left Side)

Plot ID#	Distance (m)
92	0
93	6
94	9
95	11
96	14
97	17
98	18
99	26
100	27
101	29

Transect 2 (10 plots, Left Side)

Plot ID#	Distance (m)
102	1
103	2
104	4
105	9
106	15
107	21
108	22
109	24
110	26
111	27

DRASM 1b (18 plots)

Transect 1 (10 plots, Right Side)

Plot ID#	Distance (m)
58	6
59	7
60	9
61	13
62	17
63	18
64	19
65	20
66	21
67	23

Transect 2 (4 Sub-transects, 8 plots, Left Side)

Sub-transect	Plot ID#	Distance (m)
a	68	1
a	69	4
b	70	3
b	71	4
c	72	2
c	73	4
d	74	3
d	75	5

DRASM 1e (16 plots)

Transect 1 (4 plots, Left Side)

Plot ID#	Distance (m)
76	1
77	3
78	5
79	7

Transect 2 (2 plots, Left Side)

Plot ID#	Distance (m)
80	1
81	2

Transect 3 (2 plots, Left Side)

Plot ID#	Distance (m)
82	0
83	1

Transect 4 (8 plots, Left Side)

Plot ID#	Distance (m)
84	0
85	3
86	4
87	8
88	10
89	13
90	16
91	17

APPENDIX 4. Humboldt-Toiyabe National Forest transect descriptions including length, bearing (taken from 0m), side of transect for plots (when viewed from 0m), and endpoint UTMs (NAD83, Zone 11). Number of plots at each Humboldt-Toiyabe transect, plot ID#, and distance along transect. "Distance" is the point on the transect tape where the lower left corner of the plot should be placed. Pages 44-47.

DRASA-Rose1, Transect 1: 11m long, Bearing=314°, Plots on alternating side of transect

UTM Data: Sensitive information omitted

Transect 1 (6 plots)	
Plot ID#	Distance (m)
205	1
206	2
207	3
208	5
209	6
210	9

DRASA-Rose1, Transect 2: 25m long, Bearing=228°, Plots on alternating side of transect

UTM Data: Sensitive information omitted

Transect 2 (13 plots)	
Plot ID#	Distance (m)
211	1
212	2
213	3
214	4
215	5
216	6
217	7
218	8
219	9
220	12
221	18
222	21
223	24

DRASA-Rose1, Transect 3: 11m long, Bearing=358°, Plots on alternating side of transect

UTM Data: Sensitive information omitted

Transect 3 (6 plots)	
Plot ID#	**Distance (m)**
224	1
225	5
226	6
227	7
228	8
229	9

DRASA-Rose2, Transect 1: Data not available for transect length, bearing, side of transect for plots, or UTM locations.

Transect 1 (12 plots)	
Plot ID#	**Distance (m)**
230	1
231	2
232	4
233	5
234	9
235	11
236	12
237	15
238	16
239	18
240	21
241	24

DRASA-Rose2, Transect 2: Data not available for transect length, bearing, side of transect for plots, or UTM locations.

Transect 2 (5 plots)	
Plot ID#	**Distance (m)**
178	2
179	5
180	10
181	12
182	17

DRASA-Rose2, Transect 3: Data not available for transect length, bearing, side of transect for plots, or UTM locations.

Transect 3 (6 plots)

Plot ID#	Distance (m)
247	0
248	1
249	4
250	5
251	9
252	10

DRASA-Tam, Transect 1: Data not available for transect length, bearing, side of transect for plots, or UTM locations.

Transect 1 (9 plots)

Plot ID#	Distance (m)
253	1
254	2
255	3
256	4
257	6
258	11
259	15
260	16
261	17

DRASA-Tam, Transect 2: Data not available for transect length, bearing, side of transect for plots, or UTM locations.

Transect 2 (11 plots)

Plot ID#	Distance (m)
262	1
263	3
264	4
265	6
266	10
267	12
268	14
269	16
270	17
271	22
272	24

<u>DRASA-Tam, Transect 3</u>: Data not available for transect length, bearing, side of transect for plots, or UTM locations.

Transect 3 (8 plots)

Plot ID#	Distance (m)
273	1
274	3
275	4
276	6
277	7
278	10
279	11
280	15

APPENDIX 5. Instructions and example datasheets for *Draba asterophora* monitoring. Pages 48-55.

<u>**1. Coversheet**</u> Fields at the top of the coversheet identify the population and describe environmental characteristics of the entire site. Many of these fields will not change after the initial visit (e.g. UTM coordinates, number of plots), however they should still be filled out during each revisit.

Population EO: The assigned LTBMU EO that identifies the population (e.g. DRASA1a).

Population Location: The location name used informally to identify the population (e.g. Freel Peak).

Date: Month/day/year that the fieldwork was conducted.

Surveyed by: Last name or initials of all people that participated in data collection.

Forest: The national forest where the population is located (e.g. LTBMU or HTNF).

District: The ranger district where the population is located (only applicable on the HTNF).

Elevation: The average elevation in meters of the population (could also give a range of elevations).

Slope: The average percent slope of the population (could also give a range of slope).

Aspect: The average aspect in degrees of the population (could also give a range of aspect).

USGS Quadrangle: The 7.5" USGS quad map that covers the location of the population.

Township/Range/Section/¼ Section: The township, range, section and ¼ section in which the population is located.

UTM: Easting and northing to be used to locate the population.

Zone: The UTM zone used when recording UTM coordinates (i.e. Zone 10 or Zone 11).

Datum: The UTM datum used when recording UTM coordinates (should always be NAD83).

Population/Site Description: A narrative description of the site including local topography, substrates, moisture regimes, habitat type, and significant or unique features. Describe in detail any disturbances to the population or area above the population, as well as species interactions (e.g. herbivory).

Total Number of Plots: The total number of monitoring plots at the site.

Plot Numbers: The range of Plot ID numbers at the site (e.g. 151-170).

The table in the middle of the coversheet is used to record information about the transects at each site. This information is primarily recorded at the time of monitoring establishment, but UTMs and plot photos may be recollected during each visit.

Transect Number: Transect number (1, 2, 3, etc).

Length of Transect: Transect length in meters. This is the distance between the rebar marking the two endpoints of each transect.

Transect Bearing: Transect bearing in degrees. Bearing is recorded with a compass while standing at 0-meters and looking toward the other end of the meter tape.

Plot Side: The side of the tape (when viewed from 0m) that the plots are laid down on.

UTM (0m) & **UTM (end):** The UTM coordinates that correspond to each of the endpoints of each transect. These should be recorded in the same datum and zone as recorded at the top of the datasheet (should be NAD83 – Zone 10 or 11).

Photo# (0m) & **Photo# (end):** At each revisit, take a digital photo of the length of the transect as viewed while standing at each endpoint. Record the file number of the corresponding photo (i.e. **Photo# (0m)** is taken standing at 0m looking toward the end of the meter tape at 25m for example).

Number of Plots per Transect: The number of monitoring plots that are placed along each transect.

Transect Description: Any special notes about the layout of the transect, such as whether it is parallel or perpendicular to the slope or location relative to other transects.

The lower table on the coversheet is for recording information about plots at each transect. Transect, Plot, and Distance shouldn't change after the initial transect installation, but photos should be taken and photo# recorded during each visit.

Transect: Transect number (1, 2, 3, etc).

Plot#: Plot ID number, which corresponds to the number on the tag affixed to the nail and stake chaser at the lower left corner of the plot.

Dist. (m): The distance along the meter tape where the lower left corner of the plot is placed. The bottom of the plot should be placed against the meter tape. This is typically the location of the nail with ID tag and blue stake chaser attached.

Photo#: Record the file number that corresponds to the photo of the plot.

2. Location Map Make a sketch of the physical features of the site and the location of the transects. Indicate North direction. Label transect bearings, lengths, and start and end points. The purpose of this map is to make easier the relocation of the transects.

3. Plot Datasheet This datasheet is used to record data on individual plants within each plot as well as ground cover data for the plot. All fields in this table must be filled out during every revisit. All plants that occur completely within the plot are counted. If a plant is o the edge of the plot, count and measure the entire plant if it is more than halfway in the plot, and ignore it if it is less than halfway in the plot. Plants are considered different individuals if they are greater than 2cm apart.

Transect: Transect number (1, 2, 3, etc).

Plot: Plot ID number, which corresponds to the number on the tag affixed to the nail and stake chaser at the lower left corner of the plot.

# of Plants: After all plants have been identified, mapped, and measured, count and record the total number of plants in the plot.

Plant ID: The letter ID (A, B, C, etc.) assigned to each plant when surveying sequentially through each quarter plot-sixteenth plot combination (i.e. start at 1,1 then 1,2 then 1,3, etc). This letter corresponds with the mapped location of that individual plant on the Plot Map Datasheet.

1/4 Plot: The plot frame is divided into four quarter plots that are numbered one through four starting from the upper right and moving counter-clockwise. Record the 1/4 plot corresponding to the plant's location. This is used to re-identify the individual plant during subsequent monitoring revisits.

1/16 Plot: Each quarter plot is further divided into four sixteenth plots that are numbered one through four starting from the upper right and moving counter-clockwise. Record the 1/16 plot corresponding to the plant's location. This is used to re-identify the individual plant during subsequent monitoring revisits.

Longest Diam.: Measure the longest diameter of the plant pincushion/mat. Units=centimeters.

Widest Perp. Diam.: Measure the widest diameter perpendicular to the longest diameter of the plant pincushion/mat. Units=centimeters.

Multiplier: Plant area will be derived by multiplying the longest diameter by the widest perpendicular diameter by a "multiplier." Choose a multiplier for each plant to adjust the calculation of plant area for irregular or non-square plant shape and/or incomplete plant canopy cover. The multiplier should be 0.25, 0.5, 0.75, or 1. For example, a plant with very sparse or dispersed vegetation might get a multiplier of 0.25, while a nearly square plant with dense vegetation would get a multiplier of 1. Do your best!

Plant area: No need to record in the field; this value will be calculated automatically during data entry.

 # Infl Stems: Count and record the number of inflorescence stems on each individual plant. If there are no inflorescence stems, enter a zero.

Flowers/Fruits/Dehiscent: Enter a check mark for each structure that is present on the plant (more than one can be present at the same time). If the number of inflorescence stems is zero, there should be no check marks.

Ground Cover (%Bare, %Litter, and %Rock; %*DRAS* and %Other Veg): Record the percent cover of three substrate types (bare ground, litter or rock); the total should sum to 100%. Record the percent cover of *D. asterophora* and record the percent cover of all other vegetation. All cover is from a bird's eye view (i.e. they don't overlap).

Erosion: Make notes if any erosion features are present in the plot (e.g. gullies, rills, deposition, etc).

<u>4. Plot Map Datasheet</u> This datasheet consists of blank diagrams of the plots to be used for mapping the location of individual plants. These maps will be used to relocate individuals during subsequent monitoring visits. Each plant is mapped by marking its Plant ID (A, B, C, etc) on the map in the actual location where it occurs within the plot. The quarter and sixteenth plots are further divided into a grid to make for more accurate mapping.

Plot#: Plot ID number, which corresponds to the number on the tag affixed to the nail and stake chaser at the lower left corner of the plot.

Transect#: Transect number (1, 2, 3, etc).

Distance (m): The distance along the meter tape where the lower left corner of the plot is placed. The bottom of the plot should be placed against the meter tape. This is typically the location of the nail with ID tag and blue stake chaser attached.

# of Plants in Plot: The total number of plants in the plot. Double check that this number corresponds to the number of letters drawn on the plot map and the number of plants recorded on the Plot Datasheet.

USFS Lake Tahoe Basin Management Unit Long Term *Draba asterophora* Monitoring

Population EO: ______________________ Population Location: ______________________________

Date: ______________________________ Surveyed by: ____________________________________

Forest: _____________________________ District: ____

Elevation: ______________ ft Slope: __________ % Aspect: ____________degrees T.N.

USGS Quadrangle: ________________________ Population/Site Description:

Township: _________ Range: ____________

Section: _________ ¼ Section: ____________

UTM: ________________ ; _________________

Zone: ___________ Datum: ______________

Total Number of Plots: _______ Plot Tag Numbers: _____________

Transect Number	Length of Transect (m)	Transect Bearing (° T.N.)	Plot Side (L/R)	UTM at 0m	Photo at 0m	UTM at end point	Photo at end point	# of Plots per Transect	Transect Description

Transect #	Plot #	Dist. (m)	Photo #	Plot #	Dist. (m)	Photo #	Plot #	Dist. (m)	Photo #	Plot #	Dist. (m)	Photo #	Plot #	Dist. (m)	Photo #	Plot #	Dist. (m)	Photo #	Plot #	Dist. (m)	Photo #

Coversheet

Location Map

Population EO: ____________________ Population Location: ___________________

The purpose of this map is to make easier the relocation of the transects. Make a sketch of the physical features of the site and the location of the transects. Indicate North direction. Label transect bearings, lengths, and start and end points.

Pop'n EO:______________________ Location:_____________________ Date:_____________ Surveyed by:____________________________________ Page _______ of ________

				NW=2 NE=1 SW=3 SE=4		Plant Size					Plant Phenology (check all that apply)			Ground Cover (birds eye view) (Bare + Litter + Rock = 100%)					
Transect	Plot #	# of Plants*	Plant ID (a, b, c...)	1/4 Plot	1/16 Plot	Longest Diam. (cm)	Widest Perp. Diam. (cm)	Multiplier (0.25, 0.5, 0.75, 1)	Plant Area	# Inflor. Stems	Flowers	Fruits	Dehiscent	% Bare	% Litter	% Rock	% *DRAS*	% Other Veg.	Erosion (Gully, Rill, Deposition)

*Plants are considered separate individuals if >2cm apart. If plant is not found, enter 0 for location in 1/4 and 1/16 plots.

Plot Datasheet

Pop'n EO:________________ Location:_______________ Date:_____________ Page _____ of _____

Plot # _______
Transcect # _______ Distance(m) _________
# of Plants in Plot ___________

2 1

3 4

Plot # _______
Transect # _______ Distance(m) _________
# of Plants in Plot ___________

2 1

3 4

Plot # _______
Transect # _______ Distance(m) _________
# of Plants in Plot ___________

2 1

3 4

Plot # _______
Transect # _______ Distance(m) _________
# of Plants in Plot ___________

2 1

3 4